# ELECTRICAL ENGINEERING

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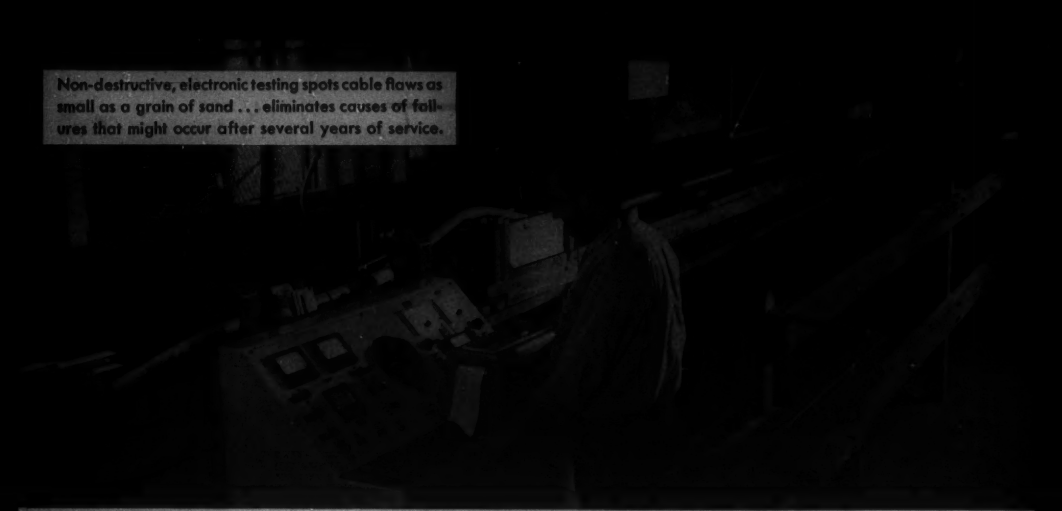

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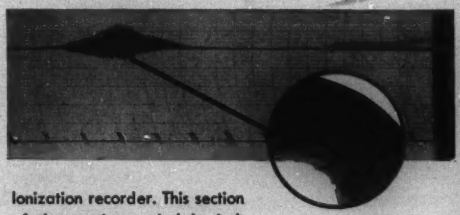

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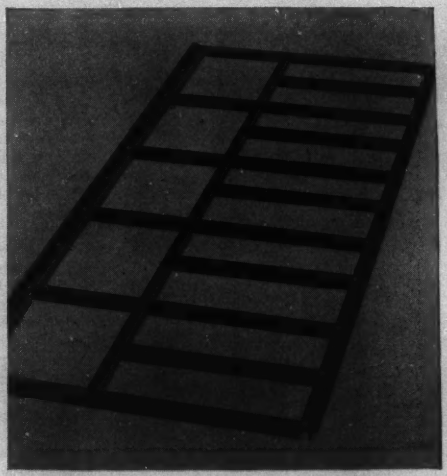

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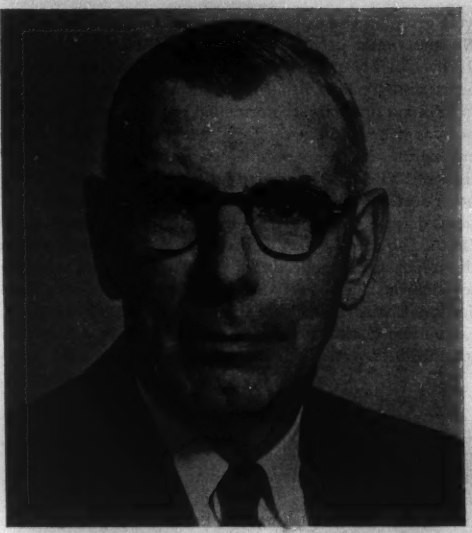
# Changing Patterns in the AIEE

M. S. COOVER
PRESIDENT AIEE



**As his term of office draws to a close, AIEE President Coover reports on the current status of the Institute, progress during the past administrative year, and the outlook for the future.**

BEFORE ATTEMPTING to assess the path of progress of our Institute through the administrative year that rapidly is drawing to a close, I want to say that I am humbly and profoundly grateful for the opportunity that you entrusted to me a year ago. It has been both a great honor and a great challenge to follow the course laid out so well by my predecessors in this office. To be sincere and truthful, it has not been a year of extra work—rather, it has been one of pleasant and more intimate service to the Institute, the kind that only an outgoing president of the Institute is in position to evaluate. The year has been generous in warm and moving experiences of the kind that makes one increasingly aware of the personal, even fraternal, bonds that unite us. My one hope is that when my score is finally totaled it will not be too low.

## OUR INSTITUTE

THE STABILITY of our Institute rests not alone with the Board of Directors and Headquarters Staff but perhaps primarily with Standing Committees, Technical Committees, special committees, Institute representatives to other societies, Section officers, and technical group activities. In reality, the stability of the Institute rests with the individual member and the manner in which he engages in the teamwork that is open to him. It is not my intention to recount all of what really has happened during the current administrative year of the Institute. You will find that summarized in the report of your Board of Directors to the membership. The report is available to you and I commend it to your thoughtful review, for after all this is your organization.

Full text of an address presented at the AIEE Summer General Meeting, Montreal, Que., Canada, June 24-28, 1957.

M. S. Coover is administrative assistant, Division of Engineering, Iowa State College, Ames, Iowa.

We are members of one of the foremost engineering organizations in the world. Our membership is worldwide. As a group, we are responsible for maintaining a high professional standing among ourselves. What we do and the way in which we do it are fundamental to our progress. How the public thinks and feels about us is of vital importance to our future. As an organization, we have wonderful opportunities to work for improvement in human welfare, to enhance our own professional stature in the judgment of the public, to co-operate constructively with our sister societies, and to assist ceaselessly in expanding the frontiers of human knowledge. But we shall lose those opportunities—and deserve to lose them—if we fail to measure up to our obligations both as individuals and as an organization. May I state, though, with appropriate modesty, that my year of observations indicates that the Institute is doing well and that it will continue to do well if we continue our search for improvements.

## DISTRICT MEETINGS

IT HAS BEEN MY PRIVILEGE to attend each of the four District Meetings that were held during the current Institute year. Each meeting was a credit to the planning and management of the respective General Committees. Attendance at each meeting exceeded expectations. In each instance, the District Executive Committee held a meeting in conjunction with the District Meeting and it was my privilege to be in attendance throughout the entire session of each one of the District Executive Committee Meetings.

As I listened to the reports of Section officers and the discussions that followed, I was impressed by the pride of accomplishments, by the diversity of objectives that each Section has established for itself, by the activities that

were given special emphasis, and by plans for the future. No one would need to look beyond these meetings to discover plenty of evidence that it takes more than kind hearts and good intentions to achieve good management.

In broad summary, the principal components of the reports as given could be cataloged under (1) items of a general nature that were more or less in common to all Sections regardless of size or occupational area, (2) items that other Sections might use in their own operations, and (3) items that were particularly suggestive of the theme "You Do the Job with People." This latter category emphasizes the importance of selecting good officers, good Committee chairmen, and good Committee members, with the Section Chairmen making it their business to see that Committee chairmen conscientiously discharge their responsibilities.

### ORGANIZATION

THE AIEE ORGANIZATION MANUAL has been developed into an extremely useful tool, especially for officers, Committee chairmen, and Committee members. It can be of greater use if the necessary information is supplied to our national Headquarters early enough so that publication and distribution can be made at the beginning of the administrative year of the Institute on August 1st. This can be accomplished if all nominations for Committee personnel are forwarded immediately in response to the National Secretary's request. He follows the AIEE Timetable that appears on the inside of the front cover of the Manual and he is entitled to your co-operation.

Furthermore, it is perhaps impractical, but it certainly would be a real contribution to efficiency of operation if we could achieve the general practice of having all changes in Bylaws and basic policies understood to become effective with the beginning of each new administrative year and, therefore, with the printing of the Organization Manual for that year.

On recommendation of the Committee on Planning and Co-ordination, our Board of Directors approved a plan of reorganization for the Institute that became effective at the beginning of the current administrative year. The Finance Committee, the Constitution and By-Laws Committee, and the Planning and Co-ordination Committee retained approximately their former relations to the Board of Directors. All other General Committees and all of the Technical Committees were realigned under a Districts and Sections Organization and five Departments identified as the Administration Department, Admissions and Advancement Department, Professional Development and Recognition Department, Publications Department, and Technical Operations Department. The complete organization chart appears in the September 1956 issue of *Electrical Engineering*. I hope that all members of the Institute have become reasonably well acquainted with the chart and the statement that accompanies it.

Experiences in operating the Institute under the adopted reorganized plan have revealed spots where further improvements can be made. The Planning and Co-ordination Committee has been giving careful study to further modifications that can be made to advantage, and it is prepared to present its recommendations.

### PUBLICATIONS

EACH MEMBER of the Institute receives the monthly publication *Electrical Engineering* and may elect to receive one of the three bimonthly publications—*Communication and Electronics*, *Applications and Industry*, or *Power Apparatus and Systems*—in consideration of payment of dues without additional charge. Additional bimonthly publications may be obtained by members at an annual subscription price of $2.50 each. The budget for the fiscal year 1957-58 as approved by our Board of Directors at its April 1957 meeting contains an expense item for publishing the bimonthlies which is up 29 per cent over 1956-57 and the anticipated income from sales of the bimonthlies is up only 16 per cent.

Two thoughts concern me: (1) How many of the bimonthlies that are received without additional charge simply go to storage, and (2) What opposition might there be to a proposal to make a charge of $2.50 for the copy that now comes free? This is as far as I will venture into the realm of statistical confusion.

### LOOKING AHEAD

TO THE BEST OF MY KNOWLEDGE, only two of our eleven Districts have a special committee whose duties, in the main, are to locate Institute members within their respective Districts who are likely candidates for National Committee appointments or national office. The committee in each of those Districts makes recommendations to their respective District Executive Committees on candidates who have become sufficiently familiar with the functions of the Institute so that if appointed or elected, the Institute would have the benefit of their services. If the committee personnel is held to a reasonably small number and composed of former District Vice-Presidents and National officers, men who should have the best acquaintance with people within their Districts, I believe that both the District and the Institute stand to gain. It is my recommendation that those Districts that now do not have that kind of assistance should seriously consider giving it a fair trial.

### UNITY

IT IS HOPED that the President's letter to all members of the American Institute of Electrical Engineers published in the June 1957 issue of *Electrical Engineering* has been widely read both inside and outside of Institute circles for the reason that it reflects the current thinking of our Board of Directors on intersociety relations. Our national engineering organizations continue to grow. Meanwhile, the present confusion and wasteful duplication of effort among activities of societies continues. Reluctance persists on the part of most of our technical and professional societies to make the necessary "give and take" adjustments for creating a truly individual member type of single organization.

Those who have been interested and active in the unity movement are familiar with the several studies,

surveys, and recommendations that have been made. In reappraising developments, our Board has made a new approach as outlined in the letter to which I made reference, realizing full well that, if followed, it is only a step in the right direction, but that it would represent progress.

At its meeting in October 1956, the Board of Directors authorized your President to make informal approaches to other societies to learn if a better mutual understanding of the AIEE statement of policy on intersociety relations could be developed. On March 18, 1957, the Presidents of the Engineers Joint Council (EJC), Engineers Council for Professional Development (ECPD), National Society of Professional Engineers (NSPE), American Society of Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME), American Institute of Chemical Engineers (AIChE), and AIEE, also the president-elect of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME), met in New York in informal conference on co-ordination of activities among the EJC, ECPD, and NSPE. Obviously, no commitments were possible and no commitments were made. Personal opinions were exchanged freely. Those present approached a meeting of minds in description of the ultimate objective which would be one over-all organization representing the entire engineering profession, subdivided as to disciplines, but having individual membership which would cover the entire field of engineering. Plans for accomplishing that objective were presented. Further informal conferences in kind are contemplated.

### ENGINEERING SOCIETIES CENTER

PROGRESS continues to be made toward bringing the proposed Engineering Societies Center to a realization. References to the report of the Special Task Committee on a New Engineering Societies Center are to be found in *Electrical Engineering*, Sept. 1956, p. 836 and Oct. 1956, pp. 920-21. The AIChE has been admitted to the group of Founder Societies that comprise the United Engineering Trustees, Inc. (UET). The UET is charged with the responsibility for handling the planning, financing, and construction of the Center.

A very substantial part of the cost of the Center must come through contributions from corporations and individuals, hence, it is expected that paralleling the raising of funds from industry, each of the Societies will solicit funds among its individual members. Those working close to the project are hopeful that the Center may be occupied within the next five years.

### OUR INSTITUTE TOMORROW

A MEASURE OF HEALTH of our Institute is the degree to which every member takes part. The sustaining lifeblood of any organization such as ours is composed of young engineers who are advancing in competence and professional stature and mingling with an older generation —working together to improve the knowledge of each succeeding generation. The vigor, inquisitiveness, and creative ideas of our younger members represent our source of new energy. They will be our Institute of tomorrow. They are an integral part of us today and they deserve all of the recognition that can be given to them. That kind of stimulus, somehow, should be so effective that it will be recognized by every student of electrical engineering even while he still is progressing toward his first degree.

Another measure of the health of our Institute is the increase within very recent years in the number of Divisions and Technical Committees to cover the important and expanding segments in electrical technology. This is an area of Institute management, however, within which we dare not become complacent. The Forums of Technical Committee Chairmen have been particularly valuable. It is important that the Chairman of each and every Technical Division and Technical Committee become thoroughly familiar with the "Scope of the Technical Operations Department."

### ACKNOWLEDGMENT

THE INSTITUTE wishes to acknowledge and express its very sincere appreciation for the services of the Directors and the Vice-Presidents who may be leaving our Board at the end of the current administrative year. To a like degree, the Institute wishes to recognize and express its very sincere appreciation to those who have served the Institute in any capacity whatsoever. Each has made his contribution to the progress of the Institute. Working with each other in the best interest of the Institute is a privilege, an opportunity, and in fact an obligation. We are grateful for the confidence shown in those who manage the affairs of the Institute. This acknowledgment includes not only your elected officers, but also all members of all committees.

To repeat, if I may, I am deeply indebted to the Institute for the privilege of devoting time to some of its activities and for the honor conferred upon me. No one could rightfully expect more loyal co-operation than you have given to your President. I know that my successor will enjoy the same spirit of helpfulness. My very genuine best wishes go with him in his new capacity.

## Lenses for Infrared Rays

The development of opaque lenses which allow invisible heat rays from subzero objects to reach a supersensitive infrared detector was announced recently by the Raytheon Manufacturing Company, Waltham, Mass. Use of the material, consisting of a silicon purified to only one part impurity in 100 million, may make it possible to detect enemy ships or airplanes from longer distances in total darkness without revealing the observer's position.

In addition, it may lead to more effective solutions of numerous guiding and tracking problems. It also could be utilized in devices for the analysis of petroleum products in refineries or in aiding chemists in the identification of new compounds.

# Earth Satellite Instrumentation

WHITNEY MATTHEWS

MEMBER AIEE

**This article discusses the use of an instrumented satellite wherein measurements made in the vehicle are transmitted to ground recording stations by means of a radio telemetering system. The design requirements of a unique telemetering encoder system are examined in the light of the limitations imposed by the over-all satellite program.**

SINCE THE END OF WORLD WAR II, much scientific information has been obtained from the upper atmosphere by means of high altitude research rockets. This technique, however, possesses many inherent limitations such as locations from which such rockets may be safely launched, the time required to penetrate the earth's atmosphere to be in a position to study transitory phenomena, and the comparatively brief time interval during which such vehicles remain aloft. An instrumented earth satellite would, on the other hand, remain continuously active for a period of several weeks in the upper atmosphere from which measurements could be made and would have a flight path traversing nearly two thirds of the earth's surface. Such a vehicle thus offers a greatly increased scope to scientific experiments from the upper atmosphere.

Fig. 1. Cutaway model of first satellite.

Three types of equipment would be carried by an instrumented artificial earth satellite. First, scientific instruments are required to measure the various parameters of the phenomena to be studied. Second, a telemetering encoder system is used to convert the output of the various scientific instruments into a single electrical signal from which the necessary information on all of these parameters may be extracted. Third, a radio transmitter modulated by the coded signal is used to convey information to a ground receiving station where a permanent record is made. This same radio transmitter provides the signal used for radio tracking of the satellite.

This discussion is intended to provide an introduction to the telemetering encoder system produced for the earth satellite science program. Particular emphasis will be placed on equipment now available for use in the first instrumented satellite. Attention will be directed primarily to those aspects which have formed a background from which the requirements for the telemetering system have been derived. For optimum weight and efficiency, equipment will be custom designed to meet the needs of a specific combination of scientific experiments to be flown in any given satellite.

## THE SATELLITE AND ITS ORBIT

THE SATELLITE CONSISTS of a hollow magnesium alloy sphere, about 20 inches in diameter, weighing approximately 21½ pounds. Fig. 1 shows a cutaway model illustrating general construction. Telemetering equipment will be located in an internal instrumentation compartment together with all components other than scientific instruments and radio antennas which must be attached to the outer shell in order to accomplish their missions. Space available for equipment in the instrumentation compartment consists of a cylinder, 5½ inches in diameter, 7½ inches high. A battery assembly will be located at the bottom of this compartment which will contain power supplies for most of the satellite equipment. Unit equipment assemblies will be fabricated on printed circuit mounting boards and encapsulated in a foam-in-place plastic to form shallow cylinders 5½ inches in diameter, ¾ inch high. These units will be assembled on two rods used to join them into a single unit which provides a wiring space for all interconnecting leads in the general manner shown in Fig. 2. The instrumentation compartment of the satellite will be thermally insulated from the outer shell to minimize thermal transients as the skin heats up when in sunlight and cools when in the

Whitney Matthews is with the Naval Research Laboratory, Washington, D. C.

earth's shadow. Neither the outer shell nor the instrumentation compartment will be completely sealed so that all equipment will operate in a high vacuum.

The satellite will be launched into an orbit making an angle of 35 degrees to 40 degrees with respect to the equator by means of a three-stage launching vehicle. Final placement into its orbit will take place approximately 300 miles above the surface of the earth. The orbit will be elliptical in shape with its nearest approach to and greatest excursion from the surface of the earth depending upon the exact direction in which the last rocket stage is fired and the velocity achieved. Pertinent details so far as the telemetering problems are concerned is that the anticipated height of the satellite above the surface of the earth in its passage over ground receiving stations is between 300 and 1,500 miles. The last rocket stage will be spin stabilized so that the satellite will have an initial spin of about two revolutions per second, which will slowly be damped out, primarily due to the effect of the earth's magnetic field. The direction of the spin axis will be essentially fixed in space so that in the first satellite the sun will lie in or near the equatorial plane of the satellite at all times. Antennas located in this equatorial plane of the satellite as it passes over the ground receiving stations will thus have varying orientations with respect to the surface of the earth, depending upon the time of day of the transit.

The satellite will circle the earth once in approximately 90 minutes. The plane of the orbit will remain fixed in space. The rotation of the earth with respect to this plane causes an apparent shift to the westward of the path of the satellite over the earth's surface somewhat as shown in Fig. 3. A typical path for the first three orbits is shown roughly from which it can be seen that ultimately these orbits would quite thoroughly traverse the unshaded area of Fig. 3.

## THE SCIENTIFIC EXPERIMENTS

Two groups of scientific experiments are planned for the first instrumented artificial earth satellite. In the first group will be an extensive study of the satellite environmental conditions. The second group will include a scientific study of solar radiation in the region of the Lyman alpha spectra of hydrogen.

In addition to information supplied regarding the upper atmosphere, environmental experiments will also supply vital information regarding operating ambient conditions for scientific equipment to be installed in succeeding satellites. Environmental experiments will include the measurement of temperature at three points in the satellite. Surface temperatures of the outer shell will be measured at one pole and at one point on the equator. The third temperature measurement is that of the instrumentation compartment. All temperatures will be measured by means of thermistors presenting a variable resistance which is a function of its temperature. Currents used to measure this resistance must be kept low to prevent heating of the thermistor due to power dissipation resulting from the sensing current. The skin temperatures are expected to vary approximately 60 C in each orbit when heated by solar radiation and cooled by radiation into space while in the earth's shadow. Mean surface temperatures are expected to lie in the range of $-10$ C to $+30$ C for current design parameters and orbital considerations. It is desired to measure surface temperatures to within $\pm 5$ C. Surface temperatures during launching may go as high as 200 C because of aerodynamic heating but will quickly return to lower values. These extreme values will not be measured accurately. Instrumentation compartment temperatures are not expected to undergo appreciable cyclic changes in one orbit due to thermal insulation from the outer shell. The instrumentation compartment temperature is expected to somewhat asymptotically approach an equilibrium temperature some 20 C to 25 C above whatever mean skin

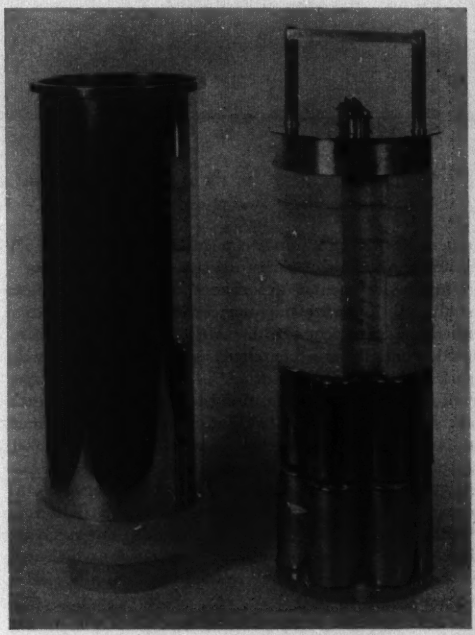


Fig. 2. Instrumentation compartment structure.

temperature is established. Instrumentation compartment temperatures are to be measured to within $\pm 2$ C over the anticipated range with somewhat poorer resolution if temperatures should deviate far from predictions.

In another type of environmental experiment, measurements will be made of surface erosion. Small erosion gauges consisting of deposited thin film resistors are cemented to the outer surface of the satellite. Surface erosion of such gauges will cause an increase in the electrical resistance which is a function of the amount of material removed. Four such erosion gauges will be used, two at polar and two at equatorial locations. It is desired to

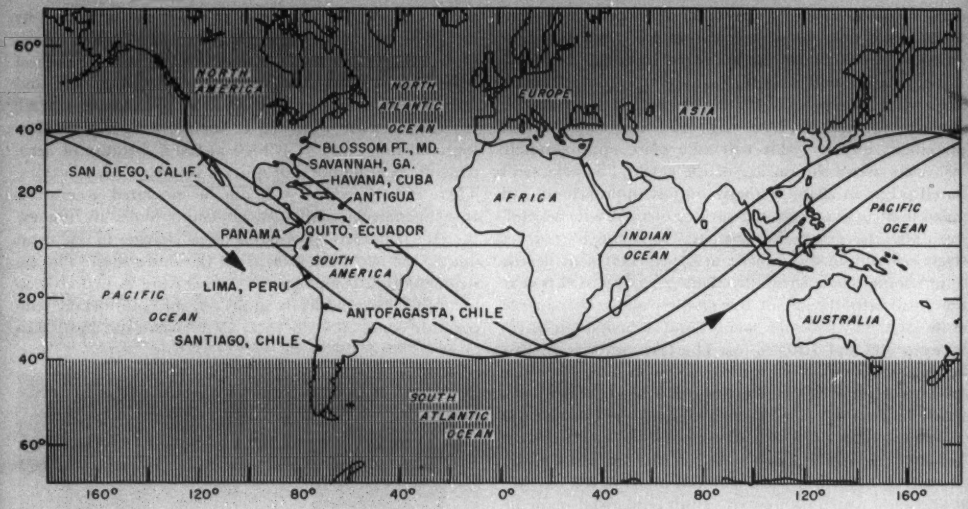



Fig. 3. Typical paths of artificial earth satellite over the earth's surface.

detect electrical resistance changes of the order of 10% in order to obtain meaningful data.

An environmental experiment will be included to study collisions with micrometeorites in space. Sensitive microphones attached to the skin of the satellite will be used essentially as accelerometers to detect collisions with such particles. A transistor amplifier with a pulse shaper will be used to provide a uniform output pulse for each such collision. It is required that information be obtained upon the cumulative number of such counts up to 1,000. A small number of such counts would be studied by taking the difference in the cumulative total between successive orbits whereas a much more rapid count rate would require a study of count changes in one receiving interval or between certain receiving stations which will occasionally "see" the satellite with less than a full orbit separation.

Collisions with larger particles capable of puncturing the outer shell will be studied by monitoring the pressure in two pressurized zones built integrally with the skin. A bellows actuated potentiometer measures the differential pressure between the two zones. It is desired to measure resistance changes of a 5,000 ohm potentiometer in approximately 10% increments. A pressure switch will monitor the absolute pressure of one zone to detect simultaneous puncture or uniform leakage of both zones. Measurement will require only an ON or OFF indication.

The second group of experiments relate to measurements pertaining to the solar radiation in the region of the Lyman alpha line in the hydrogen spectra. A photon detector will be used which is sensitive only to radiation in the spectral region under study. The solar Lyman alpha detector will present a variable signal with considerable short time variations which will be additionally modulated due to spin of the satellite on its axis. The detector will have a field of view of approximately 120 degrees and will be located on the equator so that the solar signal will exist for approximately one third of each spin period, slowly approaching a maximum when the detector is directed toward the sun. Also associated with the solar Lyman alpha experiment will be a silicon solar cell to be used for obtaining information on the aspect of the satellite with respect to the sun. It is required to obtain values for instantaneous output of the Lyman alpha detector and solar aspect cell with an accuracy of a few per cent and with good time resolution to permit time co-ordination between the two signal sources. Abnormally high values of solar Lyman alpha radiation are expected to be associated with disturbances on the surface of the sun such as solar flares. Inasmuch as these disturbances occur infrequently and at random, there is very small likelihood of such an event happening during the comparatively short time during which a telemetering record is being made as the satellite passes over a receiving station. To obtain data regarding these peak values associated with solar flares, a requirement exists for memory equipment to store information regarding the maximum output of the solar Lyman alpha signal during each orbit so that this information may be recorded during the transit over the receiving station for correlation with visually observed solar flares during that particular orbit.

## RADIO DATA TRANSMISSION

A SINGLE RADIO TRANSMITTER in the satellite is to serve the dual purpose of transmitting telemetering signals to the ground receiving station and providing signals to be

used in the Minitrack radio tracking system. The Minitrack radio tracking system utilizes radio-interferometry principles for establishing two direction angles needed to determine the direction in space from the receiving station to the satellite, as shown in Fig. 4. Measurement of angular positions will be made by comparing the electrical phase difference between signals received by pairs of antennas (shown as $A_1$, $A_2$, $A_3$, and $A_4$ in Fig. 4) located a known distance apart. This phase difference contains information regarding the difference in path length between the satellite and the pairs of antennas. With an appropriate array of antennas, the two-direction angles can be calculated uniquely. Electrical manipulation of the incoming 108-megacycle signal from the satellite permits ultimate determination of the required angles by comparison of electrical phase of signals at 500 cycles per second. Modulation of the satellite transmitter for telemetering purposes must avoid frequency components in the range from this 500-cycle-per-second reference frequency through its fifth harmonic at 2.5 kilocycles per second to prevent introduction of excessive errors in determining angular position. Transmitted power will be 100 milliwatts peak.

## GROUND RECEIVING STATIONS

SINCE THE SATELLITES in their proposed orbits are expected to traverse nearly two thirds of the total surface of the earth, it is completely impractical to provide adequate number of ground receiving stations to receive signals continually from the satellite. Satellite receiving stations will, therefore, be so located as to receive and record signals at least once each orbit with a small group of additional stations which occasionally will provide more closely spaced telemetry records. One group of stations will be located roughly in a north–south line along the East Coast of the United States and extending southward along the West Coast of South America from Washington, D. C., to Santiago, Chile, as shown in Fig. 5. One such station in the West Indies should provide early information as the satellite is being launched. Another station in California will provide additional information with less than full orbit separation. A total of 10 stations will be installed and operated as a part of the Project Vanguard earth satellite program. Technical information will be available to permit other interested groups such as universities, foreign governments, or advanced amateurs to install stations to receive and record this telemetered data.

Fig. 5. Location of ground recording sites.

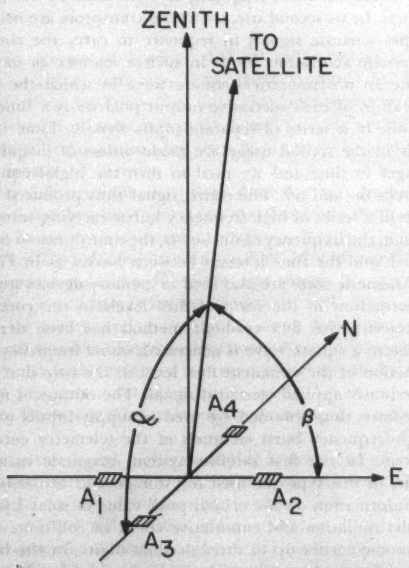



Fig. 4. Angular location of the satellite from ground stations.

Each ground station will utilize an array of high gain antennas viewing the satellite in its path approximately 30 degrees each side of zenith. This antenna system will provide a recording interval of about ¾ of a minute to 15 minutes duration for each transit of the satellite over a recording site, depending upon the height above the earth. Longer recording intervals at greater radio transmission distances will provide an opportunity to use statistical methods for obtaining improved data reliability during unfavorable signal-to-noise ratio operating conditions.

A sensitive receiver will be used with this high gain antenna array to provide signals to an instrumentation-type magnetic tape recorder for making permanent records of telemetered data. Two receiver outputs will be

provided, one conventionally detected for favorable conditions and the second a linearly detected output which essentially contains all information in the receiver i-f section for use in postrecording manipulation for extracting data under poor signal-to-noise ratio conditions.

The magnetic tape recorder will provide seven recording channels on ½-inch-wide magnetic tape moving at 30 inches per second. Other tape speeds up to 60 inches per second are available if required by special needs of experiments in subsequent satellites. In its use with the first satellite, three channels will be used for recording telemetered data, three for timing information and one spare. Telemetered data channels will record, by direct recording methods, the conventionally and linearly detected receiver output, while the third channel will utilize special pulse width recording electronics. Pulse width recording permits quite accurate reproduction of telemetered signals of the type used where favorable signal-to-noise ratios exist. Pulse width recording tends actually to conceal information where noise level is sufficient to trigger electronic circuits used. Timing channels will record a precision standard frequency for use in accurate pulse width measurements, a recording in code of the time of day at which recording was made, and a "speed-lock" channel used for synchronization of playback speeds with those at which individual recordings were made.

### TELEMETERING ENCODER SYSTEM

THE NEEDS OF THE SCIENTIFIC EXPERIMENTS, limitations imposed by the satellite operating parameters, and compatibility with associated equipment have rather closely dictated the requirements for a basically new telemetering encoder system for use in the artificial earth satellite.

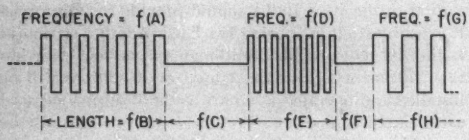



**Fig. 6. Typical encoded telemetry signal.**

A system to meet these requirements has been produced at the U. S. Naval Research Laboratory.

For practical operating circuits, weight limitations generally will appear before space limitations become critical. Weight limitations also are reflected in battery weights required for continuous operation during the active satellite life, thus demanding high electrical efficiency. Long active life with no possibility of maintenance places a premium on system reliability.

Satellite conditions leave much to be desired in signal-to-noise ratios. Low transmitted power and long transmission distances result in low received signal levels. High gain antennas viewing the solar and galactic noise combined with sensitive receivers contribute to high noise levels. This problem will be particularly acute under unfavorable conditions such as stations in the southern hemisphere where hot spots in the galactic noise exist, the sun coinciding with these hot spots, and a simultaneous maximum altitude transit. The telemetering signal should thus be one offering maximum readability in the presence of noise.

The telemetering system must be capable of accepting information from many types of input devices. The first satellite telemetering system must handle information supplied in the form of variable resistances (thermistors and pressure transducers), low values of electrical current (electrometer tubes), high currents (silicon solar cells), and voltages (battery voltage monitors).

The telemetering encoder system produced for the earth satellite program uses techniques which, as far as we know, have never before been applied to this use. Modern square-hysteresis loop magnetic core materials have the property of absorbing a fixed number of volt seconds in passing from saturation in one direction to saturation in the opposite direction. In slightly different terms, the time required for such a magnetic core to pass from saturation in one direction to saturation in the other direction is a function of the applied signal. This property is used to provide a series of time intervals which contain the necessary information regarding values of the input signals. Upon reaching saturation in either direction, these cores can provide electrical pulses for actuation of switching transistors to make a transition to the next operating mode. As applied, these principles are used in two ways. In one use, a single input signal is used to carry the flux level around the entire hysteresis loop at a rapid rate so as to provide a symmetrical square wave output whose frequency is a function of the input signal. In its second use, switching transistors are used to apply separate signals in sequence to carry the core to alternate saturation levels in such a manner as to generate an unsymmetrical square wave in which the time duration of each successive output polarity is a function of one of a series of separate input signals. Time intervals in the second usage are made orders of magnitude longer in time and are used to turn the high-frequency signals on and off. The coded signal thus produced consists of a series of high-frequency bursts carrying information in the frequency of the bursts, the time duration of the burst, and the time interval between bursts, as in Fig. 6.

Magnetic cores are also used as memory devices storing information in the form of flux levels in the cores. A nondestructive flux read-out method has been derived wherein a square wave is generated whose frequency is a function of the remanent flux level in the core due to a previously applied electrical signal. The output of memory units thus obtained are used to supply inputs to the high-frequency burst channels of the telemetry encoder system. In the first satellite system, magnetic memory units of this type are used for storage and transmission of information on the orbital peak value of solar Lyman alpha radiation and cumulative count of collisions with micrometeorites up to three decimal digits. In the latter case, three telemetering channels are used, each transmitting the current information on one digit.

High-frequency bursts as applied to the present system are in the region between 5 and 15 kc, while the time intervals during which these bursts appear and are spaced lie between 5 and 30 milliseconds duration. These values are dictated by conditions other than limitations in the telemetering system. For the high-frequency channels, an upper limit is placed by signal-to-noise considerations involving the noise bandwidth of the receiving system, while the lower limit is set by signal frequency components which would interfere with angular position accuracy of the radio tracking system. Similarly, the time intervals were established by minimum times allowable which permitted extraction of high-frequency burst information and the maximum time selection is based upon the required rate at which all telemetered channels must be scanned.

The particular combination of experiments being performed in this first satellite provide one group of quantities which are slowly varying environmental parameters in which significant information will lie in changes from one recording period to the next. A second group of measurements, such as those associated with the instantaneous solar Lyman alpha radiation experiment, require detail information as a function of time during the recording period. Thus, even though only 17 separate information channels are required including identification and calibration, the telemetry encoder system used is basically a 48-channel system in which instantaneous values of Lyman alpha and solar aspect data are repeated on several input channels spaced throughout the scan of the various input sources.

Resistive input devices will be installed with fixed resistors in parallel to minimize influence on other channels in the event of damage to vulnerable elements during launching or in orbit. These parallel resistance values are selected by resolution requirements of each associated experiment and permit restriction of dynamic range to make maximum transmission time available to the solar Lyman alpha experiment.

The basic 48-channel telemetry encoder system weighs approximately 3.2 ounces and occupies a shallow cylindrical space 5½ inches in diameter and ¾ inch high, including transmitter modulator, and modulation transformer, but exclusive of memory units. Power requirements for the telemetry encoder system are approximately 4 milliamperes at 2.7 volts so that between 3 and 4 weeks continuous active operation can be achieved with batteries weighing 2.8 ounces. The peak memory unit with orbital switch is identical in size with the telemetry encoder and weighs 2.5 ounces. Battery power for this unit is supplied at 2.7 volts and current drain is less than 0.25 milliamperes.

## Pilot's Auxiliary Indicator

Latest feature of Sperry's *APN-59* radar system is a pilot's auxiliary indicator, shown here mounted in the cockpit of an Air Force *C-97*. Like that used by the navigator, the pilot's indicator uses a 5-inch cathode ray tube with excellent definition for viewing of targets located at distances up to 240 miles.

Unique in its field, the pilot's indicator may be held on a relative bearing type of presentation while the navigator's indicator is oriented to magnetic North or some other preselected compass setting. The *APN-59*, smallest and lightest radar for its power and range, is used in U.S. Air Force troop-carrying transports and cargo aircraft for search and surveillance, store detection and other all-weather navigation purposes. Now widely used, the system is the result of an engineering and flight research program undertaken jointly by the Air Force and Sperry Gyroscope Company of Great Neck, L. I., New York.

The program was highly successful in achieving greater versatility, reliability, compact packaging, and very high resolution in range and bearing for radar units.

The *APN-59* radar system is being used at the present time currently in the Douglas *C-133* turboprop cargo plane, the Lockheed *C-130 Hercules* and the Boeing *KC-135*.

# Is the Engineer a Professional?

L. T. RADER
FELLOW AIEE

**Socio-economic pressures are creating problems that require more than technical engineering competence for their solution. To meet the challenge, the engineer must achieve professional status. The nature of this status is discussed together with the efforts the engineer must exert to earn it.**

WE ARE INTO AN ERA which is rapidly creating a staggering demand on our technical ability to just meet the opportunities and requirements of our business and society. The answer to whether we meet the challenge of our times lies not so simply in the quantity and technical competence of our engineers, but whether they are real professionals, and how business and society uses their professionalism.

Let me set a stage by quickly citing two of the socio-economic problems which confront us, my source material being Dr. L. D. Edie, who ranks among the outstanding economists of our day.

*Population growth:* Dr. Edie has stated that ". . . one subject for research that has been more neglected than any other subject in American life is the economic applications of population." The great upsurge in world population is almost unbelievable. You will probably be most impressed if you consider that roughly one twentieth of the number of people who have *ever* been born since the beginning of time are alive today.

Our world population is about 2½ billion; by the end of this century it is estimated, it will be 4 billion. There are three specific factors related to this population growth which are important:

First, the constantly rising standard of living. Although the United States population in total is increasing only 1½% a year, families with incomes above $5,000 per year are increasing 6% a year. This is the major force behind the consumer durable goods demand in this country.

The second factor is the geographical distribution resulting from the trend toward suburban life. People living in suburbs are increasing four times as fast as the nonsuburban population. It is this geographical redistribution that is creating a 10% annual increase in electrical energy consumption.

The third factor is the disproportion of the age brackets in our population growth. People of working age—the producers—increase very little. The nonworkers, too old or too young, increase very rapidly. The only way in which this gap can be filled is to give the producers more electric power, and more and better machinery. This is the crying need for automation.

*International climate:* Perhaps there will be a time in the far-off future when men can live together peacefully on earth, but in our lifetime at least it appears that military preparedness will concern us all. Currently, almost half of our national budget goes for military purposes. No longer is it sufficient to equip the combat soldier with hand-carried weapons. Today a virtual army of men far from the military front is required to put extremely complex technical weapons in the hands of a comparatively few fighting men. Our defense system, with its Texas Towers, Nike batteries, and high-speed jet interceptors, places extreme demands on the entire technical work force—from the scientists and engineers who generate and use the new knowledge, to the people who are trained to operate and maintain the components. We are not alone in this need. The Soviets currently are graduating from the engineering colleges 280 engineers per million of population, as against our national total of 186 engineers per million people.

And, because in the present period and for the forseeable future, this cold war or competitive coexistence is demanding an expansion of research the like of which we have never seen before—particularly in the field of guided missiles—Dr. Edie believes that the impact of this research work in guided missiles will have a greater effect on American industry than the impact of both atomic energy research and electronic research. Quite a novel and challenging concept.

## DEMANDS OF NEW ERA

SO BETWEEN POPULATION AND COLD WAR we have entered into an era where society's requirement for engineering skill opens the door for engineers to become real professionals. The job ahead cannot be done simply by more engineering graduates; we must take up the challenge of the professional contributor to society's advancement.

First let us define what I am talking about in this word "professional." Several years ago, Dr. W. E. Wickenden wrote an article[1] entitled, "The Second Mile." Dr. Wickenden, in addition to extensive experience in both universities and industry, had been president of the Case Institute of Technology, the American Society for Engineering Education, and the American Institute of Electrical Engineers. What he wrote about were considerations governing the professional status of engineers in a paper which has become a classic in its field.

Essentially full text of an address presented at the AIEE East-Central and Middle-Eastern District Meeting and Air Transportation Conference held in Dayton, Ohio, May 7-9, 1957.

L. T. Rader is general manager of General Electric's Specialty Control Department, Waynesboro, Virginia.

Dr. Wickenden listed four criteria as the distinctive mark of the professional man:

1. A type of activity which carries high individual responsibility and which applies special skill to problems, on a distinctly intellectual plane.

2. A motive of services beyond that of mere profit.

3. A motive of self-expression, which implies joy and pride in one's work and a self-imposed standard of excellence.

4. A conscious recognition of social duty to be fulfilled. How?—(a) By guarding the ideals and standards of one's profession; (b) By advancing it in public understanding and esteem; (c) By sharing advances in technical knowledge; and (d) By rendering gratuitous public service, in addition to that for ordinary compensation as a return to society for special advantages of education and status.

These are things which Dr. Wickenden means, with his expression of "going the second mile," which marks the true professional. We, as engineers, must do these things if we are going to earn our recognition and grow as a profession, and if we are going to make the contribution society will need from us in the era ahead. We must correct, by our actions, a fairly popular concept that engineers are all automatons who know the slide rule and little else; that they are remote and hard-shelled creatures; or that they work only in isolation, never as members of a team in their technical tasks.

Point 4 of Dr. Wickenden's criteria was "a conscious recognition of social duty to be fulfilled." We could very well ask whether engineers have a greater social responsibility than anybody else. Perhaps they do not; however, if we ask whether they have a greater opportunity to do good than anybody else, then, I think, we are on firm ground in saying that there are very few professionally trained people who have as much capability for service in a community. Engineers are trained to look for facts; to evaluate assumptions and draw logical conclusions from those facts. There are many, aspects of community life in which this kind of training could be very valuable. In addition, they have at their command a large number of practical facts which are unknown to the other professions merely because they have never been given an opportunity to absorb them. I mean by this some basic training in economics, design of simple structures, knowledge of simple accounting such as depreciation, interest on investment, technical information on power distribution, principles of illumination, or water drainage. There are many such useful items in the average engineer's memory which are completely foreign to many people in a community. This is not bragging, it is merely a consequence of the kind of training received. Much of this information can form a useful background for public service if the engineer is so motivated as to want to use it.

In the field of politics—on state and national issues—the engineer seems to be too significantly quiet. The voice of the turtle may be heard in our land, but the voice of the engineer is silent. Is it because we have not analyzed the issues, or is it because we do not want to take a position? Do we believe in right-to-work laws? Do we believe in balanced budgets and debt reduction? Is the educational problem really a serious one in this country, and what should be done to improve it? Is there a threat of complete Federal control here in the United States? There is a sin of omission particularly on the part of those who should act as leaders. A long time ago, Plato said, "The penalty good men pay for indifference to public affairs is to be ruled by evil men." and Dante in the 12th Century stated "The hottest places in Hell are reserved for those who in a period of moral crisis maintain their neutrality."

## MANAGERIAL OPPORTUNITIES

RECOGNITION AND DEVELOPMENT of his social duty will not only aid the enginering profession, but also will most assuredly aid in the personal development of the engineer into a new profession, that of management. Ralph Cordiner, president of General Electric, has stated that the biggest single problem facing the company both today and in the next 10 years, is the adequate development of the number of managers needed to run the business—general managers and managers of functions. I am sure this is true of all industries, and I am also sure the engineering group is in a favored position if we can develop ourselves in the human relationships area. I have heard many engineers say that they could not understand why people keep talking about this great need when so many capable engineers exist who are never offered these managerial jobs. The answer lies simply and completely in the fact that many of these engineers are incapable of doing a managerial job although in many cases they do not recognize this themselves. In my opinion, the greatest area in which they fall down is lack of awareness of other people. They still believe that facts can be analyzed, conclusions drawn, and action initiated without taking into account the emotions and motivations of the people with whom they deal. It may be true that engineers have had to work harder than many other professional people; that their families often could not give them the benefit of an extra three or four years in college to take an arts degree; that their jobs are very demanding and need a lot of attention; but along with this should go the realization that they are not going to make progress, as managers at least, until they clearly realize that working with people is as important as any of their technical knowledge.

One thing we can all depend upon is that business and industry is becoming more and more complex and will continue in this manner. That is why the human relationships are so important and why there is a great need for well-rounded, technically competent managers. Whether we are talking about creation of products or their application, it is evident that the engineer is going to be an important part of an increasingly complex whole. Clearly, we will not only have great need for people with outstanding ability, but also it will be essential for everyone to make the best use of all his abilities.

Whenever I hear the term "complexity" I am reminded of the very high-level committee meeting that

was closing after considering a particularly difficult subject. The chairman summarized in this way:

"Gentlemen, I am not at all sure we have solved the problem that has brought us together. In fact, after hearing the arguments and discussion today, I feel that this very complex matter has given rise to a whole new series of problems and at a much higher level of confusion."

Facetious though it may be, I think it helps illustrate my point of increasing complexity in industry.

## CRITERIA FOR PROFESSIONALISM

IF WE CAN MEASURE UP to Dr. Wickenden's criteria of a professional, here are some of the things industry and society are going to demand from the engineering profession:

1. Continuing great amounts of research and development of defense equipment that will safeguard our way of life in the international "competitive co-existence." With two very important additional factors beyond the technical challenge: First, that we produce our defense needs within our ability to support the necessary Federal tax burden. Second, that our research and development in the defense area must make corollary contribution to our commercial and industrial advancements. Our developments in defense industries must be able to contribute to our nonmilitary technology as well, if we as a nation are going to be able to justify and make best use of our defense expenditures.

2. The limitations on our working-force capacity is going to make automation of our industry a must. This means our engineers must, in turn, design and develop products which are geared to the automated process. This also will require new methods of preparing, storing, and processing design and drafting information for the input programming of our automated machines. This job cannot be done unless, our engineers are able to broaden their scope and vision to encompass the requirements of production, manufacturing, computers, and distribution processes. The engineer's responsibility no longer should end at the drafting table. You may know that we have in operation today many large milling machines with several cutting heads each automatically controlled in each of 3 dimensions. But do you also know that the complete program for these machines is developed on a computer. Surely with facilities and flexibility like this at the factory end, our engineers can and will develop better means of transmitting information to a factory than by drawings. This is only a start, but our pace depends on the ability of our engineers to know and use the potential of automation.

3. The need for business managers. Men who understand how business operates, the profit and loss system, and the financing problems. Men who understand shop problems, scheduling, purchasing, distribution, labor relations, as well as engineering. The outstanding problem is the development of the needed managers of the future who must be able to double and triple the supply of goods with very little increase in work force. Engineers are in the driver's seat for these managerial jobs. The research and technological advancement of our products, along with the automated processes, a higher standard of living, and just purely more complexity, makes the technically trained man, if he can broaden his business and social attributes, a natural for the managerial job.

4. Industry will require its engineers to become business oriented. We need engineers who do not do engineering for the sake of engineering, but for the sake of a business. This means better integration than we have had—primarily with the marketing function. We need engineers who are able to visualize and define the products, services, and systems that will satisfy the customers' need and wants. We need engineers who will design to a cost, who will design to a time schedule, who will design to the requirements of an automated factory—and in each case understand why.

I feel that in these four areas rests the crux of what industry and society expects from our engineers. If engineers meet this challenge, I am sure he, you in this case, will have measured up to the requirements of a professional man.

There is one big thing that business needs to do for the engineer. I feel this strongly and I believe you will agree with me. We need to prune out the miscellaneous chores which inevitably accumulate in the load our experienced engineers have to shoulder. We need to make our engineering positions challenging. If we are going to expect big professional accomplishments from our engineers, we need to take away from his daily assignment the nonchallenging work, and give it to draftsmen, drafting designers, technicians, and engineering aides. To have qualified technical men working on nonchallenging tasks is extreme economic folly. We must free our engineers for true engineering contributions commensurate with their talents. For many years we have heard noted educators and industrialists advocate this, but there seems to be little actual work on its implementation .

And now, why did Dr. Wickenden call his task "The Second Mile?" He took the phrase from the Sermon on the Mount found in the Bible under Matthew. The phrase was, "Whosoever shall compel thee to go one mile—go with him twain." And I quote:

> "Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession."

## REFERENCE

1. The Second Mile, W. E. Wickenden, *Electrical Engineering*, vol. 54, May 1935, pp. 471-73.

# A Microwave System for Protective Relaying

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PIONEERING in the use of a microwave system for complete high-speed relay protection for 115-kv pipe-type cables and transfer tripping protection for associated transformers, the Boston Edison Company has had a 2,000-mc microwave system in operation for approximately one year.

In order to provide adequate facilities for an expanding power system, a new substation was constructed in the Brighton area of Boston, Mass. This station has two 4-winding step-down transformers of 100-mva capacity each, directly connected to two 115-kv pipe-type cables supplied from Mystic Generating Station. Initial operation of the cables was at 25 kv. Transfer tripping became a necessity on order to protect the transformers at Brighton adequately. Supervisory control, telemetering, high-speed relaying, and a voice communication channel were also required between Mystic and Brighton Stations.

Microwave was selected as being the most applicable communications medium for this particular situation, in preference to pilot wires, leased lines, or power-line carrier.

In view of the importance of the protective relaying which would operate over the microwave system, it was necessary to design the system to minimize outage time. Consequently, complete standby r-f equipment was installed in such a manner as to provide a space diversity system. The system consisted of a primary transmitter and receiver and a complete standby transmitter and receiver with separate parabolic antennas, 6 feet in diameter, spaced 30 feet vertically apart. A transfer system was incorporated, whereby the standby transmitter would instantly take over in the event of a primary transmitter failure and the standby receiver would take over in the event of primary receiver trouble or a fade in signal strength.

The primary path, top parabola to top parabola, is line of sight with a 45-db fade margin while the standby path, lower parabola to lower parabola, has some obstruction, which results in a 30-db fade margin. Power for the microwave and multiplex equipment is provided by two 5-kw continuous power sets.

During the first year of operation, the major troubles encountered have been, for the most part, external to the r-f equipment.

The first major trouble encountered was in the multiplex frequency-shift transmitters. The transmitters are crystal controlled, with the crystals installed in thermostatically controlled ovens. After about three months of operation, these ovens would not hold the temperature within the required limits. The trouble was corrected by replacing the ovens with similar ovens produced by another manufacturer.

During the first three months of operation, the line relaying operated satisfactorily in that it blocked successfully on several external line faults, one of these being a transformed pothead failure close to the Mystic 25-kv bus. However, in January 1956, the line-relaying scheme failed to block satisfactorily, as one of the lines opened at Brighton on a high-speed ground relay operation during an external fault off the Mystic 25-kv bus. After an intensive investigation, it was found that the starting elements of the primary protective relays would bounce when the value of current through them was a low multiple of the tap setting. The frequency-shift transmitters and receivers would follow this contact bounce, due to their extremely fast response time, thereby removing holding current prematurely and allowing a false trip to occur. An *RC* time constant was added to the relay circuit in such a manner as to introduce a time delay of 2.5 cycles. With this addition, the blocking signal is maintained during the interval of time when the starting element contacts are bouncing open. This time delay does not delay tripping for internal faults.

During the first year of operation, 100% reliability of the microwave path would have been attained were it not for trouble that occurred in the control circuit of the continuous power sets in August 1956. A heavy system fault produced a serious drop in voltage at the a-c motor terminals, causing the automatic control system to transfer the driving source of the continuous power set to the d-c motor. When this occurred, the d-c motor oversped for a short time, causing the a-c generator to deliver a transient overvoltage to the microwave equipment. A sufficient number of fuses and tubes blew to shut down both the primary and standby equipment. The trouble was found in a relay used in the speed control circuit in the field of the d-c motor. A new type relay is being installed and an instantaneous overvoltage relay is being added which will transfer the microwave equipment directly to station service in the event the output voltage of the a-c generator becomes excessive.

The over-all reliability of the microwave system has been exceedingly good at 99.98% over the period of one year.

Microwave, as part of a protective relaying system, has met the stringent requirements of reliability. Once installed, microwave provides a flexible means for the installation of an almost endless variety of functions for control or other purposes necessary for the efficient operation of an expanding electric utility system.

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# Some Operational Problems of the Nuclear Power Plant

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**In view of the increasing application of nuclear steam generators in future power plants, it is desirable to examine the problems of nuclear plant operation. Among the areas covered are start-up, normal operation, normal and emergency shutdown, maintenance, refueling, and manpower.**

IN THE YEARS immediately ahead, the nuclear-fueled steam generator will be applied frequently in place of the boiler used in today's steam power plants. In fact, the atomic plants already in design exceed a million kilowatts capacity. The industry has been so deeply involved in the evaluation of the economic feasibility of nuclear power that very little attention has been devoted to the problems which are to be expected in the operation of these plants. In general, this phase of the problem has been dismissed with one of two statements: (a) the nuclear plant should be only slightly more difficult to operate than the conventional, or (b) the nuclear plant will require about the same operating crew as the conventional plant. The authors subscribe to both of these general statements, but they also believe the time has come to look more closely at the details of nuclear plant operation. S. Glasstone[1] indicates less than 1 mill per kw-hr variation in the estimated ultimate total cost of power between five reactor types. These are recognized to be rough estimates, but they do indicate that rather small factors of cost, such as operation and maintenance, may influence strongly the final selection of reactor type.

It is not feasible to examine the operational problems of all these reactor types. In fact, the authors can do little more than point out a few of the problems to be dealt with in one reactor type. If this article can provide the spark to initiate papers setting forth the problems for each type, it will have served an important purpose. The authors would implore the industry to prepare, as soon as possible, a series of papers reporting the results of studies to define the operational costs of the various reactor types. The papers by L. R. Love and G. N. Oldham[2] represent a beginning on this program.

The pressurized water reactor has been selected for discussion here for several reasons. Aside from the authors' greater familiarity with this type, much more information is generally available on the plant. An even more important reason is to be found in the fact that of the seven large nuclear plants planned for construction in the next six years, three will utilize pressurized water reactors and a fourth is a modification thereof.

The normal performance of a nuclear plant is generally accepted as excellent for power production. Most of the problems discussed herein have to do with auxiliary systems and emergency conditions. Before discussing these in detail it is in order to develop a common concept of the plant under consideration.

The problems are grouped under the following operational headings: start-up, normal operation, shutdown, maintenance, refueling, and manpower.

## THE REACTOR TYPE

THE PRESSURIZED WATER REACTOR (Fig. 1), derives heat energy from the fission of uranium and other heavy atoms, which are maintained in a fuel structure of solid rods or plates, inside a reactor or pressure vessel. This energy is transported in hot water, approximately 2,000 psia (pounds per square inch, absolute) and 500 to 600 F, to the steam generator, where water in a separate system is boiled to produce steam for the turbine. Depending upon the plant size, one or more heat transfer loops and steam generators may be utilized to remove the heat from a single reactor. The water in these loops is maintained with less than 2 ppm (parts per million) impurities by a purification system. As mentioned previously, a system is provided to pressurize the water to 2,000 psia. A make-up and drain system, with connections to a water supply of high purity and a waste disposal system, is required to keep the appropriate water level in the system. When heat energy is not required to drive the turbine, heat must be removed from the reactor by the shutdown cooling system. Reactor control and radiation monitoring of high reliability are required for plant safety.

## START-UP

THE START-UP PROBLEMS depend to some extent on the previous history of plant operation. For example, there are certain special precautions to be observed in the initial start-up of a new plant. Similar problems arise when a new fuel structure, of modified design to take advantage of development progress, is put into operation. Such operating periods are assumed to be carefully supervised by the equipment manufacturer and are of such infrequent occurrence as to warrant no more than mention here. The first case is encountered only once in the plant lifetime and the second can be expected at perhaps 1- to 5-year intervals at first and less frequently later.

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The start-up of a cold plant can be expected at irregular intervals and should be accomplished by the normal operating crew. It is, therefore, of more immediate and general interest. For the moment, let us assume that the systems, primary and secondary, approximately 300 to 600 gallons per mw capacity, are filled with water of the desired purity, approximately 1 to 2 ppm.

The first requirement of start-up is, of course, the check-out of instrumentation and components to insure proper function. The items to be checked and the procedure will be peculiar in many cases for the nuclear plant, but the problem is not essentially different from that encountered in any other plant.

Cranking power to drive the plant auxiliaries must be supplied. For the electric utility application, this usually means energizing the auxiliary power bus from the system. For isolated units, a diesel generator may be utilized to provide this power. Presently available data[3] indicate the auxiliary requirements to be about 8 to 9% of rated output and a sizable fraction of this, at least one third and perhaps two thirds, is needed during start-up.

Oxygen scavenging, described by Love,[2] may require appreciable time (up to 4 hours) prior to actual start-up, if the system has been refilled with supply water. This scavenging is accomplished by the addition of hydrazine. To accomplish this, the system is pressurized just sufficiently to provide the required net positive suction pressure (100 to 200 psi) at the main coolant pump intakes either with the pressurizer or with the charging pumps. The main pumps are then used to circulate the hydrazine solution and permit the hydrazine oxygen reaction to take place. During the oxygen scavenging and throughout the start-up procedure, all main coolant valves should be open.

Design practice is such that the reactor will be shut down before full insertion of the control rods is reached. However, operating practice is to take advantage of this extra margin of available rod insertion as a safety factor on shutdown. Therefore, the control rods must be pulled for a considerable distance before the reactor reaches criticality and begins to produce power. In order to avoid accidental overshoot, this rod withdrawal is done at a very slow rate and a period of one-half hour may be so consumed. This approach to criticality should be made only with the main coolant pumps operating. Likewise, the electric heaters in the pressurizer should be operating so that a steam bubble space is available in the system for water expansion. Having obtained criticality, the plant is ready for warm-up.

This operation requires careful co-ordination with the pressurizer for two reasons. First, the temperature of the steam bubble in the pressurizer must exceed the maximum fuel-surface temperature to prevent boiling and burnout. Second, the required net positive pressure must be maintained at the pump suction to prevent cavitation. Maximum pressurizer heater power demand occurs at this time. The actual rate of system warm-up is limited to avoid excessive thermal stresses in the reactor vessel walls. About 100 to 200 degrees per hour may be permitted. The allowable rate of rise is influenced by the material

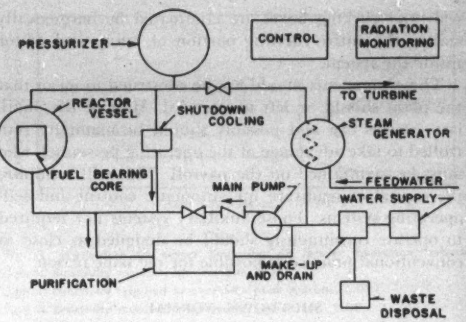


Fig. 1. Schematic diagram of pressurized water reactor plant.

selection and is inversely proportional to the wall thickness. The rise from room temperature to 500 F will require, then, about 2½ to 4 hours.

During the warm-up period the density of the water will drop from 62.4 to 49.6 pounds per cubic foot at 500 F. To accommodate this expansion, it is necessary to drain from 30 to 60 gallons per mw capacity from the system. The purity of this water is such as to make it economically desirable to store rather than waste it.

The time required for a cold plant start-up may require up to 8 hours. This compares with 5 to 6 hours for a conventional plant. The time required for a hot plant restart is short, perhaps 1 to 2 hours, and compares favorably with that for a conventional unit.

## NORMAL OPERATION

THE OPERATION OF AN ATOMIC PLANT in the normal power range appears to be an exceedingly routine task. Design practice is to produce a reactor with a negative temperature coefficient, which makes the unit self-regulating to a large degree. The control system is automatic in most cases, and is normally designed to assist the inherent self-regulating characteristic of the reactor. This means that the reactor follows the power demand of the turbine-generator unit essentially without adjustment by the operators.

The reactor plant can be designed to follow the load swings demanded by system requirements. This means that the normal turbine limitations are the main restrictions on plant operation.

The plant is capable of sustained operation at any fraction of full load above the minimum, 5 to 10%, set by turbine-generator restrictions.

The radioactivity, present throughout the primary system during operation, prevents approach for maintenance. Of course, this does not apply to many of the auxiliary systems. The design, then, must be such as to minimize the need for attention for long periods if the plant is to meet the needs of the electric utility application. Minimization of maintenance is obtained by the use of such components as the canned motor pump, where bearings are lubricated by the pumped fluid and shaft

seals and packing boxes are eliminated by hermetically sealing the entire rotating portion of pump and motor inside the system.

These comments should not be construed to mean that the plant should be left unattended. Most of the auxiliary systems can and possibly should be manually controlled to take advantage of the operating personnel, who must be maintained on the payroll. This will minimize the capital expenditure for automatic control and self-operating systems. Those auxiliary systems not required to operate continuously should be designed as close to conventional practice as possible for the same reason.

## SHUTDOWN—NORMAL

THE PRODUCTION OF HEAT ENERGY can be stopped in three distinct ways. In certain cases, the system power demand will be zero for short periods. In such instances, it is desirable and generally feasible to keep the reactor at temperature and critical without producing appreciable power. The auxiliaries are kept in operation during such down time, and the power required may be taken either from the main turbine or the system. In other cases, the power demand will be zero for extended periods of time, and it will be desired to make the reactor subcritical by complete insertion of the control rods. The plant can then be cooled down and will require the minimum of attention during the shutdown period. The same thermal stress considerations limit reactor cooldown as were discussed under start-up. In this latter case, the restart corresponds to that described previously. These two are routine operations and are discussed in this section. The third is an emergency procedure and will be covered in the following section.

Regardless of the manner in which the plant is shut down, two important problems must be solved. One of these is the removal of heat which the fission products continue to release even after the chain reaction has been arrested. This condition is indicated in Fig. 2. A reactor, operating at power $P_0$, is shut down by inserting the control rods at time $C$. Neglecting, for the moment, the transient condition immediately following $C$, the heat release after shutdown[4] is found by the use of the equation

$$\frac{P(t)}{P_0} \simeq 0.0315\ (t)^{-0.2}$$

where

$10 \text{ seconds} < t < 100 \text{ days}$
$P(t) =$ heat power release as a function of time after shutdown
$P_0 =$ heat power release prior to shutdown
$t =$ time after shutdown in seconds

at $t = 10$ seconds,

$$t = 10^{-0.2} = \frac{1}{1.585} = 0.63$$

$$\frac{P_{10}}{P_0} = 0.0315 \times 0.63 = 0.0198$$

at $t = 100$ seconds,

$$\frac{P_{100}}{P_0} = 0.0125$$

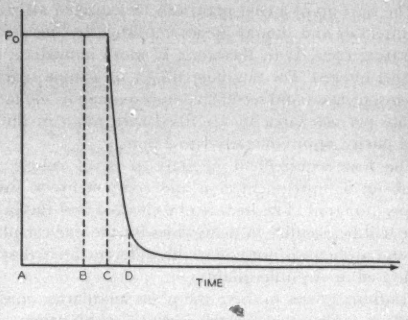


Fig. 2. Typical curve of heat after shutdown.

Although this is not a large amount of power, it would be sufficient to damage the reactor core if not removed. The plant design must be worked out to assure proper function after shutdown. The plant layout is made to insure circulation of water in the primary loop by thermal siphon action. Even in the extreme case of loss of auxiliary power to the main coolant pumps, the heat after shutdown is thereby removed.

When the loops are to be taken out of service for maintenance or refueling, the heat must be removed with a separate auxiliary shutdown cooling system, see Fig. 1. This system consists of a pump and heat exchanger, along with suitable valves and piping. It may be manually controlled and is not required during plant operation at power.

The second important problem after shutdown is the build-up of poisons.

When the uranium atom fissions, the two parts form atoms of different chemical materials. As the result of this process, many new materials are formed in the core. Some of these present large target areas for the absorption of neutrons. The worst offender in this respect is xenon (Xe). A relatively small amount of Xe is formed directly, but over 5% of the fissions produce tellurium (Te). By the process of radioactive decay this element decays to iodine (I) and then Xe:

$$Te^{135} \rightarrow I^{135} \rightarrow Xe^{135}$$

The half-lives for radioactive decay for these elements[1] are:

| | |
|---|---|
| Te | 2 minutes |
| I | 6.7 hours |
| Xe | 9.2 hours |

In each of these changes, a high energy electron (a beta particle) is emitted. As a result of these processes, an appreciable amount of Xe is present in a reacting core.

The magnitude of the neutron-absorbing characteristic of $Xe^{135}$ is indicated by its target area of 3.2 million barns (1 barn $= 10^{-24}$ square centimeters). By comparison, cadmium (Cd) is considered a good control rod material with a target area of 3,300 barns.

$Xe^{135}$ disappears from the reactor in two ways. It

decays naturally to cesium (Cs) or, absorbing a neutron, becomes $Xe^{136}$ which is an isotope of only 0.15 barns target area. When the chain reaction is in progress, both of these processes are operative to limit the build-up of $Xe^{135}$ to a definite equilibrium value. Immediately following shutdown from power, the $Xe^{135}$ concentration rises sharply as the $Te^{135}$ and $I^{135}$ decay into $Xe^{135}$ and only the $Xe^{135}$ decay to $Cs^{135}$ operates to remove it. Gradually these decay actions are carried toward completion and the $Xe^{135}$ concentration again falls off as shown by the solid curve in Fig. 3.

The equilibrium $Xe^{135}$ must be compensated by the addition of fuel beyond the critical mass. This is in addition to the fuel added for burnout, that is the uranium which is destroyed by fission. If the reactor operating schedule is such as to call for restart during the period (which may be as large as 40 hours) that transient $Xe^{135}$ exceeds equilibrium, an additional amount of fuel must be included. For the electric utility application, this requirement is not considered essential. The fuel added for burnout is adequate in most cases to provide transient $Xe^{136}$ override for the first 50 to 75% of core life. During the remaining portion of core life, the operation of the plant is limited. The power output and hence the neutron flux must be maintained at such a level as to control the $Xe^{135}$ concentration. It is perfectly feasible to operate the plant at outputs throughout the permissible range of turbine operation, although the rate of change of power may be limited near the end of core life. This should not work any hardship where the plant is part of a utility system. It must be taken into consideration in the design of units for isolated service; for example, for ship propulsion where maneuverability demands wide power swings.

Another aspect of this problem has to do with the rapid burnout of transient $Xe^{135}$, which occurs when the plant is started near the peak $Xe^{135}$ period. This is shown by the dotted line in Fig. 3. Relatively rapid control rod insertion is required to compensate for the removal of this neutron-absorbing material. In fact, this will be the criterion for control rod speed in most cases.

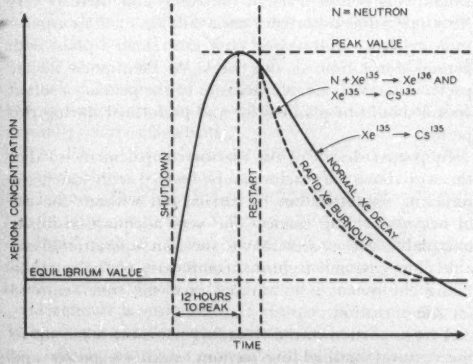


**Fig. 3. Typical curve of transient xenon after shutdown.**

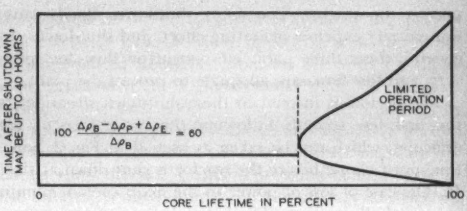


**Fig. 4. Illustration of xenon limitation on reactor operation, where**
**$\Delta\rho_B$ = Reactivity inserted for burnout, 0.05**
**$\Delta\rho_P$ = Reactivity required to overcome peak poisons, 0.07**
**$\Delta\rho_E$ = Reactivity required to overcome equilibrium, 0.05**

For the purpose of illustrating the xenon control problem, simplified calculations were made on a thermal reactor assumed to be designed to generate 150 million Btu per hour of heat energy with an average neutron flux of $1.6 \times 10^{13}$ neutrons per square centimeter per second. The limitation on operation is shown in Fig. 4. During the first 60% of core lifetime the poisons impose no limit on operation. During the final 40% of core lifetime, a period of 10 hours or less, decreasing to zero at the end of life, is available for normal restart. This curve, that is the limited operation portion of core life, is influenced almost directly by neutron flux and, hence, by power level. This curve has the same shape as the peak xenon curve in Fig. 3, except that the base is the equilibrium value.

During the "limited operation period" the plant can be restarted at reduced temperature. If a temperature coefficient of reactivity of $-5 \times 10^{-4}\Delta\rho$ per degree F is assumed and if $\Delta\rho_P - \Delta\rho_E = 0.02$, the temperature reduction required at the end of life is $0.020/(5 \times 10^{-4}) = 40$ F.

## SHUTDOWN—EMERGENCY

BURNS WAS, of course, perfectly right in saying that "The best-laid schemes o' mice an' men gang aft a-gley." The reactor designer struggles to produce a trouble-free unit, and the operator inspects and checks for every conceivable weak link before starting the plant. In spite of all this, power plants will get into trouble on occasion. The plant should be shut down as rapidly as possible under certain conditions to avoid overheating and damage to the core. The condition to be avoided is that situation where the heat being generated in the reactor core cannot be transferred to the coolant and thereby removed. This can occur, for instance, if the neutron flux rises above the safe level causing the heat generation rate to rise. Another cause would be loss of system pressure, causing boiling of the cooling water and inability to transfer the heat to the coolant. A third cause, loss of coolant flow, results in inability to remove the heat from the core.

Protection against these emergencies is obtained by the application of an overriding automatic shutdown system, called "scram" circuitry because it is usually designed to operate very rapidly. It is necessary to select the scram signals very carefully. Too few scrams fail to

protect the reactor. Too many shutdown signals cause unnecessary expense, operating effort, and shutdowns. In general, these three parameters—neutron flux, low pressure, and low flow—are adequate to protect the plant.

The period of interest in these shutdown situations is the first few seconds following the occurrence of the difficulty, which can be taken as time *B* in Fig. 2. Some time must elapse before the reactor is shut down at time *D*. The case of loss of power to the main coolant pumps is a good illustration. The inertia of these coolant systems must be examined in each design and in some cases additional inertia must be added to insure that the transient heat energy is safely removed. A. R. Jones and C. S. Baldwin[8] discuss various means for providing this inertia.

The design of the reactor system should be predicated on fail-safe shutdown on loss of auxiliary power. However, it is very desirable that the radiation detection equipment, for example, as well as certain other auxiliary loads be continuously supplied with power. These loads are normally connected to a "vital bus," which is supplied from a combination of sources including the auxiliary bus, a battery, and even a diesel generator.

## MAINTENANCE

THE MAINTENANCE of a nuclear power plant differs from that associated with a conventional plant because the problem of radiation in introduced. When the plant is in operation, the primary coolant loop cannot be approached for maintenance. Special considerations must be observed in the design to eliminate the necessity for frequent attention.[6] Corrosion products, which would become highly radioactive, are removed to minimize the activity in the loop. Valve and pump seals and packings are eliminated by the use of hermetically sealed units. Provisions are made to valve off malfunctioning components pending scheduled shutdown.

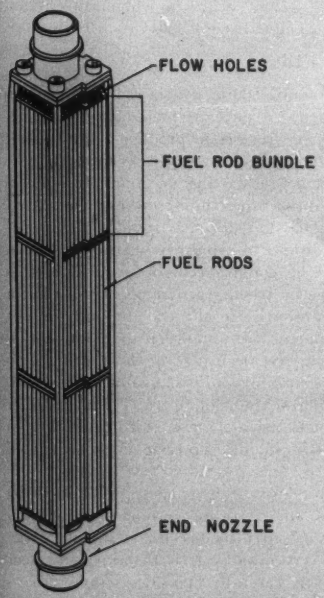


Fig. 5. Reactor fuel assembly.

In plants above 20,000-kw rating, more than one heat transfer loop and steam generator would be utilized. In such units, a major leak in the heat exchanger is isolable in this manner. Of course, the unit must be operated at part load pending maintenance.

All maintenance of a pressurized water nuclear power plant can be performed in complete safety by the strict observance of fairly simple ventilating, waste disposal, and health physics practices. Careful training and supervision of maintenance personnel is of great importance. For example, crew members should be trained to use radiation monitoring equipment and protective clothing, hats, gloves, coveralls, boots, etc. Covering a floor with butcher and blotter paper to catch radioactive drippings can save endless hours of decontamination work. Control of tools and equipment prevents the spread of contamination throughout the plant.

Appreciable quantities of water are required for rinse prior to any maintenance of systems handling radioactive coolant. In those instances where radioactive particles have plated out on the surface of the malfunctioning part, an acid rinse followed by water rinse can materially reduce the difficulty, time, and manpower required for maintenance. Such a technique would be particularly applicable if fuel element failure had been experienced.

The normal maintenance schedule should coincide with the fuel-reloading schedule, which is discussed in the following section.

## REFUELING

THE REFUELING of a pressurized water reactor must, in general, be done by taking the plant off the line, cooling down, and opening the reactor vessel. The present state of the art allows fuel element design for periods of continuous operation of approximately one year. Intensive testing and development work is being carried on to extend this period. Present estimates—and there is very little operating experience yet available to draw upon—indicate that a well-trained crew can reload a plant with a total down time of one week. As mentioned in the previous section, the maintenance of the primary coolant system should be planned for and performed during this period.

By proper design of the reactor compartment, so that the area above the reactor can be flooded with water, the refueling operation can be carried out without the use of heavy shielding coffins. The very adequate visibility obtainable with water makes such an operation desirable. The cost and technical complexity of the manipulating equipment is minimized as is the time required for the operation.

A large portion of the reloading period is taken up in the removal of shielding sections, auxiliary power and cooling connections, and the removal of the reactor-vessel

head. Present practice is to weld the closure with either strength or seal welds. However, experience indicates that gasket closure is adequate and should be adopted to reduce cost and handling time. Several designs for quick-opening heads are under study, and some further advancement can be expected in this area.

The handling of the heavy reactor-vessel head requires carefully designed jigs and fixtures to insure against damage of control mechanisms and core during removal and replacement.

After the spent fuel charge has been replaced and the plant is in operation, the crew can devote its attention to the preparation of the spent fuel for shipment to the reprocessing center. Underwater tools can be utilized to remove nonfuel-bearing parts such as the end nozzles (Fig. 5). After cooling, the fuel-bearing assemblies are to be loaded into lead coffins for shipment. These coffins are approximately 10 inches in wall thickness, and may include a cooling system. Inasmuch as the water in the fuel storage pit will probably be contaminated, these coffins will require scrubbing to remove radioactive material from their outer surfaces prior to shipment.

The waste disposal will be most heavily loaded at the refueling and maintenance period and storage for subsequent disposal should be considered in the design.

## MANPOWER

Conclusions as to the manpower requirements for an atomic plant are hard to reach. Lyman[6] indicates that 129 positions are planned for the Shippingport (Pa.) plant. He indicates further that at least 26 of these will be engaged in the development portion of the project and estimates that the final operating crew can probably be reduced to 81. He compares this with a complement of 66 men for a conventional plant of the same rating. These data point up the extra effort needed to get a new plant type in operation and the extra personnel needed to take and analyze the operational data obtained from the first plants. The value of such data to the industry is obvious and it is unnecessary to dwell on the desirability of obtaining and reporting it.

During the early years of the nuclear power program, the operating crew will require special training and skills. All of these special requirements will become commonplace as the industry develops and should be regarded as developmental in nature. It seems to the authors that it would be unfair and unwise to handle the charges for such efforts in any other way.

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# Huge Power Shovel Operates in Kentucky Mine

One of the largest mobile land machines ever built in the United States, a 2,400-ton power shovel named the "River Queen," has gone to work in a new open-pit coal mine in western Kentucky. Taller than a 13-story building, heavier than a Navy destroyer, and able to take more than 80 tons of rock and earth in a single bite, this new shovel is being used to uncover two seams of bituminous coal in the River Queen Mine near Central City, Ky. The mine is owned jointly by the W. G. Duncan Coal Co. and Peabody Coal Co., and operated by the latter. When in full operation, its output will be 2 million tons of coal annually, mine officials say.

The River Queen, a model *1650-B* special long-range stripping shovel equipped with a 55-cubic-yard dipper, is the largest power shovel ever built by Bucyrus-Erie Co., South Milwaukee, Wis. It stands 140 feet high and is equipped with a 145-foot boom and an 86-foot dipper handle. In each pass of its dipper, the River Queen excavates enough material to fill a room 14 by 12 by 9 feet.

The shovel is powered by 15 General Electric motors—11 for digging and 4 for propelling. The main motors are two 1,500-hp a-c motor-generator-set synchronous-driving units. The main functional d-c motors consist of four hoist motors rated at 375 hp each; three swing motors at 187½-hp each; two crowd motors at 187½-hp each, and four 200-hp propel motors.

# Evaluating Scientific Personnel

E. I. GREEN
FELLOW AIEE

**A performance rating system is described for one of the largest industrial laboratories in the world, employing an extremely heterogeneous scientific personnel whose contributions in many cases are intangible. This situation has many unique facets, involving as it does the comparison of "horses and apples," and psychological factors in human judgment.**

ONE OF THE MOST PERPLEXING and challenging problems occasioned by human collaboration in industrial enterprise is that of evaluating the relative performance of individuals. Unfortunately, the schemes thus far devised for that purpose seem by and large best adapted to organizations where fairly close similarity exists in the work of substantial numbers of employees, and usually where some direct measurement, either of the contributions of individual employees or groups, or of related factors, is feasible. Thus, in most industrial organizations such criteria as production records, work analyses, profit indexes and the like can be used either to assist in arriving at performance ratings or to secure a check on their validity. The problem of comparing the relative performance of professional scientific personnel in a large research and development laboratory, where the contributors are drawn from many disciplines and where the contributions are, more often than not, supplementary, diverse, and intangible, presents unique facets. This article describes procedures which have been used with some success in rating the relative performance of scientific personnel under such circumstances. These procedures have evoked interest because they seem to permit some degree of precision in this particular area of technological management.

The organization in which the procedures to be discussed have been utilized is one of the largest industrial laboratories in the world. In carrying out its functions, it employs several thousand scientists and engineers, including physicists, chemists, physical chemists, ceramists, metallurgists, mathematical physicists, mathematicians, statisticians, and electrical and mechanical engineers, together with a sprinkling of other specialists. The management is confronted with the necessity of comparing the relative contributions of these different individuals to the over-all achievement. That this is a vital matter in the much-publicized field of human relations will require no elaboration.

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The author wishes to acknowledge the contributions made to this topic by J. G. Ferguson and by a committee headed by R. I. Wilkinson.

## PURPOSES

OCCASIONAL SKEPTICS may, and do, question the need for performance comparisons. Some may agree that such comparisons are necessary, yet maintain that they need not be quantitative. Others may persuade themselves that performance rating is incompatible with professional endeavor. Such doubts and queries reflect a fundamental kind of misunderstanding. The fact is, of course, that quantitative performance comparisons are inescapable. Whenever selective increases in salary are decided upon, quantitative ratings of performance have been arrived at. As long as ours is a free enterprise system, where financial reward is some function of individual contribution, so long will performance rating remain basic to our social structure. It follows that the first purpose of the procedures to be described is to assist in salary administration, or, to put it more concretely, to support the objective of adjusting the salary of each individual fairly in comparison with his co-workers.

Granted the necessity of performance ratings for salary administration, the next question is: "How can they be used for other purposes?" The methods under consideration have been employed for most of the other generally recognized objectives of performance rating, including personnel guidance and training, and appraisal for transfers and promotions. Some distinction can be drawn, however, between the kinds of ratings needed for salary administration and those for such diagnostic purposes. Salary administration requires quantitative judgment of relative over-all performance, whereas most other aims are satisfied by qualitative judgments of specific capabilities and characteristics. Fortunately, the analysis of particular traits is a desirable preliminary to over-all appraisal, whereas over-all appraisal serves as a check on detailed analysis, so that in practice the two kinds of ratings can be made to supplement one another.

## DEFINITIONS

AT THIS STAGE some definition of terms is in order. This discussion has to do with what is termed "performance rating." The choice of this term in preference to the more common one of "merit rating" is deliberate, born of experience. To many people, the word "merit" connotes inherent and, hence, practically unalterable, capability. Performance, however, is generally regarded as the product of motivation and ability and therefore susceptible of modification at will. The word "performance," therefore, has better psychological appeal and conduces to better understanding of the procedures on the part of those concerned.

When intended for salary administration, perform-

ance rating may be defined as "the judgment of the relative worth to the organization of different individuals, based primarily on their present job assignments." It may be profitable to dwell briefly on these words. To begin with, performance rating is a judgment. And what is a judgment? A compounding of appropriate dictionary phrases might give, for present purposes, a definition something like this: "an operation of the mind, involving comparison and discrimination, by which conclusions as to values and relations are reached."

Next, the process should appraise relative worth. Individuals are compared with one another. There is no absolute yardstick.

Third, it should be a judgment of worth to the organization. An individual has many kinds of worth. Other kinds, such as worth to family or community, are vastly important, but are outside the present area of concern.

The judgment of worth should be based primarily on present job assignment. A mechanical designer is not rated for his ability to develop electronic circuits, and neither is an engineer who develops capacitors rated for what he might be able to do in designing networks. Such conjectural judgments lead to absurdities. On this point, the reader may ask: "Doesn't this require a comparison of horses and apples?" Indeed it does. In practice, however, despite the extreme heterogeneity of work in the organization, it has proved feasible to compare individuals who are engaged in different jobs provided those who make the comparison understand those jobs.

Note the word "primarily" in the definition. Many instances arise where individuals should not be rated exclusively on their present job assignment. In the case of younger engineers in particular, weight must be assigned to potentialities. Also, if a man is versatile, so that he can be readily moved from one job to another, he merits, other things being equal, an edge over the man who is adapted to only one job.

## EARLIER METHODS

THE METHODS to be described represent no lightning creation, but rather the evolutionary product of a number of years, with contributions by many individuals. Through the years most of the various rating techniques described in the literature have been used to some extent.[1,2] Understanding may therefore be facilitated by a brief review of some of the earlier approaches made by the organization under discussion to the problem of performance rating. Some of the things which have characterized these experiences will doubtless be common to the experiences of others.

Still within the memory of many now in the organization is the time when performance rating and salary adjustment were coincident and to a considerable extent synonymous. Despite most conscientious effort, the familiar disadvantages of this approach were present in some measure. Laudation and lung power were instrumentalities whereby appreciative supervisors tended to seek increases for their people. There was an inclination to proportion the amount of each increase to current performance, without considering existing salary. Hence, it was difficult to correct for those inequities which are bound to enter any salary scheme as people and judgments and organizational patterns and assignments change.

There was, in addition, a tendency for the selectivity of raises to vary as between departments. Some were inclined to give flat increases across-the-board, others to be discriminatory. It also was difficult to keep the so-called "boss effect" from occasionally entering the picture. This effect may be defined as the tendency of a boss far up the line of organization to modify, on the basis of old or inadequate information about an individual, the amount of raise determined as proper by those more familiar with current performance, and perhaps even to repeat this year after year, with cumulative effect. This effect might be either positive or negative. Because the organization was then much smaller, these various tendencies were mostly latent, and the over-all salary pattern was in fact remarkably equitable. With the present expanded organization, the results obtainable through such a process would be far less satisfactory.

## LADDER LISTS

IN THE SEARCH for better ways of evaluating people, certain areas began to use rank-order lists or so-called "ladder" lists. This, of course, is the simple scheme of taking all the names in some organizational subdivision and arranging these in order of estimated worth. Such rankings represented a definite step forward. The uniform performance steps of a ladder list are inconsistent, however, with practical situations where the separations between successive names may range from nothing to a wide gap. Difficulty entered as it became necessary to merge the lists for different groups of people. Usually this was accomplished by a statistical interleaving process, notwithstanding a size of sample such that statistical distribution of performance was not expected. A further trouble was that all ages were mixed together. Inasmuch as salary, in our society, normally increases with age, the ladder lists could not be correlated directly with salary data and hence were ill-adapted for use in salary adjustment. Despite these drawbacks, the ladder lists yielded much useful information. As will appear later, a similar approach plays an important part in present evaluation techniques.

## RATING CHARTS

NEXT CAME WHAT MAY BE CALLED the era of rating charts. Because rating forms or charts have become something of a fad, they need to be placed in proper perspective, which will take some paragraphs in doing.

Well before World War II, charts for rating scientific personnel were employed in a limited and sporadic way in different parts of the organization. When these early plans demonstrated the utility of simple rating charts, more elaborate ones were devised. Increasing attention was paid to the selection of factors or traits to be rated, to the relative weighting of these traits, to the type of scale used for evaluation, and to ways of improving accuracy.

## Performance Rating Form

RATER _____ DATE _____

How long have you known employee? _____ YRS. ENGINEER _____ DEPT. _____

How long has he been under your supervision? _____ YRS. Age _____ Service _____

What is his present assignment? _____

How long on this or related work? _____ YRS.

| | Trait | Well Below Average | Somewhat Below Average | Average (Usual) | Somewhat Above Average (Better Than Most) | Well Above Average (Outstanding) | Weights | Weighted Score |
|---|---|---|---|---|---|---|---|---|
| | | — \| 30 \| — 25 \| \| 35 | — \| 45 \| — 40 \| \| 50 | — \| 60 \| — 55 \| \| 65 | — \| 75 \| — 70 \| \| 80 | — \| 90 \| — 85 \| \| 95 | | |
| 1 | INITIATIVE—Enterprise; drive; capacity for independent action; degree to which he assumes responsibility when orders are lacking; degree to which he follows through on a job despite obstacles. | | | | | | 1 | |
| 2 | COOPERATIVENESS—The trait of working wholeheartedly both with and for others in an open-minded objective fashion; possession of the qualities of tact, courtesy, friendliness and tolerance. | | | | | | 1 | |
| 3 | QUANTITY OF WORK—Amount of useful output in the light of the opportunities afforded by the job. The output may be written or otherwise. | | | | | | 2 | |
| 4 | QUALITY OF WORK—The general excellence of all kinds of output, including written material, with consideration given to the difficulty of the job. Accuracy, thoroughness and dependability of output should be considered but not quantity. In the case of supervisors, this trait includes skill in directing and guiding men. | | | | | | 2 | |
| 5 | ORIGINALITY—Creativeness, including imagination and inventiveness. | | | | | | 1 | |
| 6 | EXPRESSION—Facility in expressing ideas both orally and in writing. This implies the ability to communicate ideas in a logical, coherent fashion and the ability to summarize. | | | | | | 1 | |
| 7 | ENGINEERING JUDGMENT—Skill in analyzing situations and arriving at sound conclusions even though the available data are incomplete or seemingly contradictory. | | | | | | 1 | |
| 8 | VERSATILITY, ADAPTABILITY—Capable of doing successfully several lines of work, as need arises. | | | | | | 1 | |

WEIGHTED TOTAL . . [ ]

| | | |
|---|---|---|
| 9 | SPECIAL VALUE—This is the place to recognize any special values to the Company which have not adequately been covered in the items above. Examples of Special Values are: Recognition as an expert or authority, extreme inventiveness, unusual contributions to Company prestige, or any unusual ability which contributes to the Company's welfare. Most MTS's will not be cited here. | Cite Special Value here: [ ] * |

8/9/54 *Score to be assigned at a departmental conference TOTAL . . . . [ ]

**Fig. 1. Example of performance rating chart.**

As to the number of evaluation factors or traits, experience indicated that this should be between 5 and 15, with each one clearly defined on the rating form. In the case of supervisors, it was concluded that ability to lead, understand, and develop people should be rated separately. Because it appeared preferable to select traits of particular importance to the work carried on by the group of individuals being rated, the rating charts tended in time to become tailor-made for different areas of work. Although uniform weighting of traits was recognized as simpler, nonuniform weights with integral weighing factors such as 1, 2, or 3 were adjudged more realistic, and seemed to hold no terrors for scientifically trained personnel.

Over the years, it became clear that the scale employed in evaluating any particular trait should be calibrated in relative rather than absolute terms. Proof of this came from an excursion in which absolute definitions were written under the scale numbers for each trait. Thus, under "judgment," for example, degrees each representing two divisions on a scale of 10 were distinguished as: 1-2, Notably lacking in judgment; 3-4, Shows tendency toward unsound judgment; 5-6, Acts judiciously in ordinary circumstances; 7-8, Habitually shows good judgment; 9-10, Shows exceptionally sound judgment under all circumstances. What happened in practice was that the raters were reluctant to use the ends of the scale, particularly the lower end describing individuals as "notably lacking in judgment." The ratings, therefore, tended to bunch around the middle. This tendency was avoided by marking the scale with such words as "Average," "Slightly Above Average," etc., as can be seen in Fig. 1.

Out of such travails came numerous rating charts. None of these was perfect—in fact, it has been aptly observed that the only perfect rating chart is the one that has never been used. A particular 9-trait, 5-degree assessment form which has been employed with good success is shown in Fig. 1.

The perpetual poser, of course, was how to improve the accuracy obtained with rating charts. This was no Gordian knot to be treated by a single stroke of the sword. It became a continuing challenge. The most important source of inaccuracy, namely, lack of knowledge of ratees, is likewise the most difficult of correction even though the remedy is obvious. Nevertheless, recognition of this limitation on accuracy proved valuable in stimulating observance and analysis of performance.

Inaccuracy was found to result also from biases, predilections, and caprices, usually unconscious, on the part of the raters. Such propensities could at least be mitigated by training the raters. One stumbling-block, for example, was the well-known "halo" effect, that is, the tendency to judge all traits as similar in degree to one which is especially striking in the individual in question. This has sometimes been described as false associative thinking. The result might be either positive or negative halos. The best corrective was the familiar technique of comparing all individuals on each factor separately, instead of proceeding to rate all factors successively for each individual.

From the start it was clear that ratings should be based on the combined judgments of several qualified persons. Such multiple ratings afforded a basis for the use of statistical processes to evaluate the raters and introduce corrections. Statistical methods were employed also to obtain a forced distribution of ratings by controlling the average, the standard deviation, etc. This was actually a groping toward the system to be described later.

There is another source of inaccuracy common in rating charts, which seems to have escaped attention in most quarters. Because rating charts are usually drawn in order to add values for different traits, they tend to overrate ability at the expense of performance. There is no gainsaying that technical ability is a beautiful thing, but ability without motivation for achievement is like faith without works. One way of getting around this difficulty is to divide the rating factors into two groups, and to multiply the sum of the ability factors by the sum of the productivity factors.

In due course, it became apparent that the rating charts which were being used, in many cases, yielded answers at variance with over-all judgment of relative worth. Thus, the rating chart is likely to favor a man with well-rounded characteristics as compared with one who is so outstanding in one respect that deficiencies in others may be of less concern. Low co-operativeness, for example, is of less significance, and perhaps more understandable, when coupled with high creative genius. Such discrepancies between chart ratings and over-all judgment suggest that a single chart is not right for all types of people. Of greater moment, however, is the fact that the over-all answer seems usually to be better known than the components which enter into it.

A further limitation of rating charts is that they tend to overemphasize the mathematical approach to the evaluation problem and to encourage unwarranted numerical precision at the risk of losing sight of the fundamental problem. Also, unless held in check, rating charts tend toward absolute evaluation, which is decidedly more difficult than relative appraisal. It seems likely that no matter how skillfully new rating charts are devised, how thoroughly the raters are trained, and how meticulously statistical processes are applied, the results will exhibit imperfect correlation with over-all appraisal. Moreover, the rating chart does not, in itself, solve the problem of evaluating personnel of different ages.

On the other hand, the rating chart should not go undervalued. It is of unquestioned utility in focusing attention on traits which play a part in over-all judgment and in pinpointing specific characteristics which are important in the development of each individual. And, with the advent of other methods yet to be described, rating charts can play a prominent supporting role in over-all comparisons.

### CHECK LISTS AND FORCED CHOICES

ANOTHER KIND OF FORM, somewhat allied to the performance rating chart, has been used with good success

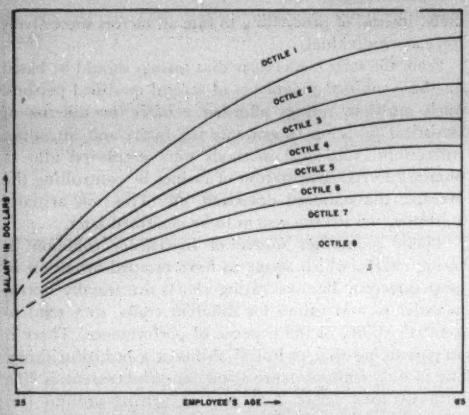


Fig. 2. Hypothetical salary—octile curves.

in many parts of the organization. This is a so-called "Employee Development and Evaluation Form" devised by Prof. D. W. Taylor of Stanford University. It consists of two parts: (1) a development check-list comprising a large number of ability and behavior factors, with boxes for checking (a) those in which the subject most needs improvement, and (b) those in which he is especially good; followed by (2) an evaluation summary requiring forced choices between a series of seven statements representing descriptive degrees (without numerical values) for six major aspects of job performance. The admirable feature of separate forms for supervisors and nonsupervisors is provided. This form has proved of great value in the development of people and in cultivating objective judgment. It is not of itself adapted, however, to yield quantitative over-all performance comparisons.

No trial has been made of forced-choice techniques arrange to give numerical results.[3,4] It is at least questionable, however, whether any forced-choice form could be devised which would be suited to a heterogeneous group of scientists, and it seems likely, too, that any such techniques would be subject to certain of the difficulties encountered with rating charts.

## OCTILES

In parallel with the activity on rating charts, a rating method which has come to be known as the "octile system" was being born. In explaining this, the simplest starting point is salary. Surveys of the organization's salary position vis-a-vis comparable industrial laboratories began by comparing curves of median salary versus age. Closer examination, however, required additional curves. Subdivision of the areas above and below the median gave curves bounding the quartiles for each age, and another subdivision, octiles. Fig. 2 shows, for illustrative purposes, some imaginary octile curves. In practice, these curves are obtained by taking five-year moving averages and are factual except for minor smoothing to eliminate statistical irregularities. All scientists and engineers in the organization, including all levels of supervision, are included in the data. By definition, each octile comprehends one eighth of the total number of people. These salary octile curves are made available as information to everyone concerned.

In drawing the curves, age is used as the independent variable. Other abscissas, as, for example, years of experience or years from first degree, might be more precise but are much more awkward. Although age is not an ideal index, especially for the younger members of the staff, it becomes before many years a satisfactory measure, and practical convenience dictates its use.

With curves of this sort available, the salary octile position of each individual can be readily determined. The problem now is to relate this information to performance. An approach to the answer was found in a fairly simple scheme devised by Messrs. J. B. Fisk and W. Shockley. The first step was to make up a list of all the people in a large group, perhaps a department, with one column of names for each salary octile as determined from curves like those of Fig. 2. Next, each person's performance was considered and a decision reached as to whether he is placed properly or should be moving to the right or left, with any desirable motion indicated by an arrow pointing in the appropriate direction. Anyone who should move two octiles received an arrow of double length, and so on. The judgments of performance might be merely over-all judgments of relative worth, or they might be sharpened up by performance rating charts or other devices. Through this process there emerged a set of performance or merit octiles which could be compared with salary octiles. Here at long last was a basis for quantitative comparison of salary and performance. The comparison was relative, as it should be, and based on judgment, as it must be. It indicated what salary corrections were needed, so that plans could be made to accomplish these over an appropriate period.

## AGE GROUPS

Originally, the performance octile comparisons were made with people of all ages grouped together. This was advantageous in extending the area of cross-comparisons and in making it possible to use the traits of the older and more experienced engineers as a help in understanding and appraising the younger ones. It was only natural, however, to rate the older persons largely on realized performance, whereas for the younger ones considerable weight was given to potentialities. This gave rise to a fallacious effect. Many of the younger engineers looked out of place octilewise and appeared to need substantial upward salary correction. On further thought, it was realized that such a pitfall is to be expected when carefully selected young engineers are compared with older ones. In the beginning, all youngsters are promising, else they would not be hired. No one can predict the degree to which the promise will be realized through the years. Furthermore, broad relations between age groups are the concern of salary planning, not of performance

rating. The primary objective of the rating process is, therefore, to appraise performance relative to contemporaries and for this purpose individual comparisons between engineers of widely different ages are irrelevant. Thus, it gradually became clear that for performance evaluation people should be divided into age groups, and comparisons made first of individuals within a single age group and then with immediately adjacent age groups.

## THE STEP-CHART TECHNIQUE

THE AGE-GROUP APPROACH was a distinct improvement. It had the drawback, however, that the number of people available for comparison in any age group was small. People began to wonder whether something similar to the moving-average scheme used for the salary octiles could not be devised for performance octiles. It was clear that a performance octile chart could be derived in much the same way as the salary octile chart by plotting a scatter diagram of age versus absolute performance. The difficulty, of course, arose from the fact that there was no absolute measure of performance.

The principal means for getting around this difficulty turned out to be quite simple—a chart with 40 horizontal lines and wide enough to write the names of a large number of individuals subdivided into age groups. Each of the 40 lines is chosen to represent one step of performance or merit. The choice of number of steps is a purely arbitrary one. The number 40 was selected for two reasons: first, a convenient size of sheet with 40 lines happened to be available in the stockroom, and second, this number gave plenty of room for all the names that had to be entered, with adequate separations where desired. There was even room at the bottom of the sheet to leave several lines blank (presumably corresponding to lower performance steps which could only be imagined in some part of the organization other than the one whose personnel were being compared).

Next, all of the people in the group being rated are listed on the 40-step chart in such a way that names of persons judged equal in performance appear on the same line, each name being listed under the appropriate age group. This listing is based on multiple judgments of supervisors, arrived at through a variety of methods, including rating charts, ladder lists, and the like. Initial comparisons are made for small segments of the group and these are combined on the basis of careful discussion and cross-checking. A hypothetical chart indicating how the names might be distributed over different age groups and performance steps is shown in Fig. 3. The division into age groups facilitates the comparison of contemporaries. One of the most interesting and reassuring things found in using the 40-step chart is the close agreement which can be reached in the placing of names.

Now comes the final step of deriving performance octiles. This can be done fairly well by merely inspecting the 40-step chart and drawing in appropriate boundaries. Another scheme which has been used is to draw a scatter chart with age as the abscissa, the performance step obtained from the preceding chart as ordinate, and each individual represented by a dot. By the use of moving averages, it is a simple procedure to establish performance octile boundaries such that one eighth of the people are included in each stripe. From these curves there results for each person a performance octile which can be compared with his salary octile, yielding the information needed for salary administration. As indicated by previous discussion, the shape of the boundary curves as a function of age has little significance.

One way in which the performance octile curves differ from the salary octile curves deserves mention. The salary octiles have most frequently been drawn for the entire organization. The performance octiles usually embrace a smaller division, preferably the largest for which common knowledge of individual performance permits good cross-comparisons. Inasmuch as the proper salary distribution pattern for the personnel in one part of the organization is likely to differ somewhat from that for the whole, some adjustment of the performance octile curves may be required to make them conform to the salary pattern which cross-comparisons between areas indicate to be desirable. Thus, the final performance ratings for a particular area may contain, in a given "octile," slightly more or less than one-eighth of the people.

So much by way of explanation of the method. A brief discussion of a few related factors now is in order. The question of how often to conduct performance ratings has resolved itself quite simply. Because it has long been the practice of the organization to review all salaries about once a year, an annual interval has turned out to be a natural and satisfactory one for performance ratings. By carrying out the performance rating about midway between salary reviews, judgments of people are emancipated from questions of dollars, a material contribution to objectivity.

It has been found advantageous to carry through each new performance rating without considering present salary position or looking back to previous performance standings. For successful operation of this or, for that matter, any performance rating method, all of those concerned must become convinced that new judgments are made each time. It must be clear that no one is tagged permanently with a particular octile and that no person or group has a vested interest in any octile. Although a large population of supervisors is to be expected in the upper octiles, these octiles are not reserved exclusively for supervisors.

A question which had to be answered rather early in this matter was whether a person could find out his salary and performance octile position. To satisfy this desire, arrangements were made for anyone to obtain such information from his supervisor. Although specific information on performance octile position is given if requested, in many cases the person wishes merely to know whether he is around average, or somewhat above or below, or in some other range. Much more important than the knowledge of precise performance standing is advice on ways in which performance can be improved. Each person has a right to demand and get such advice from his supervisor.

In the beginning, there was considerable worry about Octile 8—a feeling that some stigma was associated with this position. Gradually, the true meaning of the situation became clear. By definition, there is bound to be an Octile 8, comprising one eighth of the people. Gradually it is coming to be understood that a person in Octile 8 is compared, not with the world at large, but with a highly selected group of scientific people. Anyone in Octile 8 can and should be a valuable contributor, and should find no stigma in this rating unless his abilities would permit a higher one.

## CONCLUSION

ALTHOUGH THE OCTILE APPROACH NOW is being used rather generally across the organization, experience with the exact processes which have been described has been limited to a few areas. Procedures in other areas are in some cases similar and in others divergent. No single method is being standardized. Performance rating practice are still evolving, and further development, selection, and trial will be required before thoughts of achieving standardization could be had.

Experience thus far seems to demonstrate that the performance octile method which has been outlined possesses a number of valuable features, in particular: (1) it is a practical method, imposing no inordinate mechanical effort; (2) it largely eliminates age as a factor in performance comparisons; (3) it divorces the evaluation of performance from the distribution of dollars; (4) it facilitates the recognition of changes in individuals and changes in judgment; (5) it permits the supplemental use of other performance rating methods; (6) it affords a quantitative comparison of performance and salary; (7) it provides a systematic way of allocating salary increases; (8) it facilitates the correction of previous salary inequities; (9) it is helpful for cross-comparisons of personnel in different segments of a large organization; and (10) it can readily be adapted to furnish information for personnel development, promotions and transfers.

Finally, it may be profitable to mention one or two questions which may be raised. One which came up frequently in the beginning was this: "Doesn't this method of performance rating beget competition?" The answer, of course, is that the competition is neither more nor less than that already associated with salary increases, and that competition is in fact fundamental to our free enterprise system where financial reward is a powerful incentive to achievement. To be sure, other rewards must not be forgotten: the gratification of a job well done, the joy of understanding new things, the thrill of playing a part in extending the frontiers of science, and the satisfaction derived from recognition of one's work by others.

The recurrent question about any performance rating method seems to be: "How accurate is it?" The mechanism which has been described seems to make possible a greater accuracy than previous techniques. The basic limitation on accuracy is not the mechanism itself, but knowledge about people. The process of judging people is a soul-searching one, which in the last analysis must be tackled in much the same way as any scientific problem, through painstaking accumulation of data and a resolute quest for truth.

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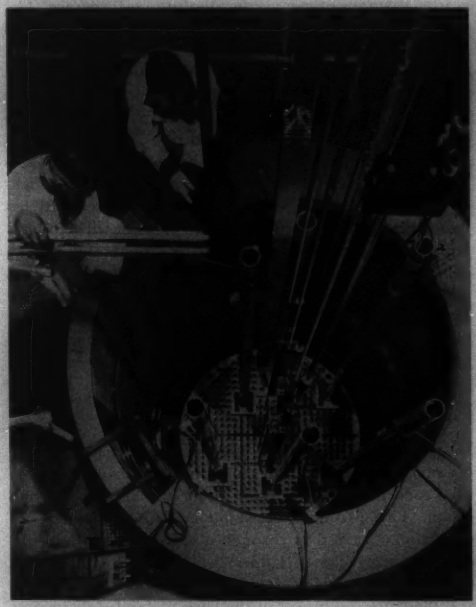
## Power Reactor Rehearsal



The full-scale experimental version of the core of the first power producing reactor to be licensed by the U. S. Atomic Energy Commission today completed its initial series of tests involving controlled fission chain reactions at the Babcock & Wilcox Company's Critical Experiment Laboratory near Lynchburg, Va. Photo shows view looking down into tank of the critical experiment reactor. Fuel elements comprising "core" stand on pins on round grid plate at bottom of tank. Neutron-absorbing rods, used to control chain reaction of assembled core, are in position among fuel elements. Long tubes extending from grid plate contain various instruments for test and control. Tank is filled with water when reactor is operating.

# Core-Reset Functions

G. C. FETH
ASSOCIATE MEMBER AIEE

THE INPUT or control requirements of magnetic amplifiers are influenced to a great extent by the "dynamic" properties of the core, i.e., by the sensitiveness of the ferromagnetic core materials to changing magnetic flux. Attempts to describe analytically the over-all core behavior in terms of the magnetization processes within the material are hindered by the complexity of the mathematics involved and by the lack of an accurate evaluation of the pertinent physical constants of the material. The objective of this article is to determine experimentally an approximate relationship between significant variables which describe the electromagnetic behavior of these cores; this work is limited to cores wound of 50% nickel-iron, grain-oriented tapes.

A physical model for flux reversal in such materials attributes the change of flux to the net motion of domain walls separating regions of positive from regions of negative saturation flux density. The magnetomotive force $F$ applied to the material affects the formation of regions of reversed magnetization at the tape surfaces and is the motivating force for the movement of the walls through the tape. The wall motion, giving rise to a net time-rate of change $\phi'$ of core flux, is opposed by eddy currents induced in the conducting magnetic tape, by spin-relaxation phenomena, and by other effects. Saturation occurs when the domain walls have swept throughout the tape leaving everywhere a flux density of like sign. At power frequencies, the time derivatives of core flux other than $\phi'$ are found experimentally to have negligible effects. Thus, at any time during the flux reversal process the over-all magnetic state of the core is described in terms of $F$, and of $\phi'$, and of the domain wall configuration. In processes of unidirectional flux reset from saturation the effects of the wall configuration may be adequately expressed for certain practical purposes by the flux level $\phi$; then the magnetic state of the core can be expressed in terms of the three variables $F$, $\phi'$, and $\phi$.

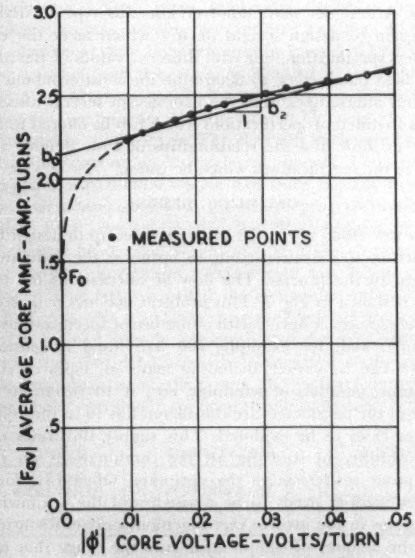



Fig. 1. Results of $F_{av}$ versus $|\phi'|$ test.

Experimentation to determine the functional relationship between these three variables was performed by applying square waves of voltage to the core and measuring the average resetting mmf $|F_{av}|$ corresponding to each amplitude of core voltage $|\phi'|$. (The volt-time integral of a half cycle of core voltage was maintained just less than twice the saturation flux.) Results of this test are shown in Fig. 1. Designating the coercive mmf as $F_o$ a function of the form:

$$|F_{av}| - |F_o| = a_2 |\phi'|^{a_3} \tag{1}$$

fits this data quite well. In the limiting case as $\phi'$ goes to zero the relationship between $F$ and $\phi$ can be found from geometric considerations for "square-loop" materials.

Assuming that the value of $\partial F/\partial \phi$ at constant $\phi'$ is independent of $\phi'$, the core-reset function is:

$$F = F_o + a_1\phi + a_2 (-\phi')^{a_3} \tag{2}$$

(For reset $F$, $F_o$, $a_2$ and $\phi'$ are all negative numbers; $a_3$ was in the range 0.20 to 0.31.) A linear approximation of the $F_{av}$ vs $\phi'$ curve can be made as shown in Fig. 1; this results in a linearized core-reset function:

$$F = b_0 + a_1 \phi + b_2 \phi' \tag{3}$$

This function is more convenient to use; it is applicable in those problems where the errors introduced at small values of $\phi'$ are not excessive.

The core-reset functions can be used to calculate the transfer characteristics of magnetic amplifiers, to explain the negative slope of certain dynamic hysteresis loops, to evaluate power and energy flow in magnetic amplifier control circuits. Thus, they may facilitate the incorporation of the present understanding of dynamic phenomena into the general philosophy and analysis of magnetic amplifier operation.

Digest of paper 57-95, "Core-Reset Functions in Magnetic Amplifier Analysis: Part I. A Core-Reset Function," recommended by the Committee on Magnetic Amplifiers and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Communication and Electronics*, 1957.

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The author wishes to acknowledge the valuable guidance of his thesis supervisor, Professor L. A. Finzi of Carnegie Institute of Technology.

# The Computing Revolution

E. L. HARDER
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**This is the second and concluding article on developments in the computing field. The use of the computer as an engineering and research tool is examined and its growing application in business and manufacturing is noted.**

IN THE AREA of computers in engineering and research as in automatic control discussed in the first article, both analog and digital computers play an important part. Engineering design calculations are going through three distinct stages. The first stage can be done by any computer, the second stage on intermediate or large size computers depending on the particular problem, and the third stage, only with some difficulty, on the largest and fastest computers of today. These will profit considerably by further advances in the computers.

The first stage is the performance calculation, illustrated in Fig. 5, in which the designer uses the computer as a tool in design. He programs into the computer his design formulas so that once he has specified the dimensions and materials for a particular case, or possibly the impedances in the case of a motor, the computer will go through the performance calculations and determine the performance for that particular configuration. He can then try as many configurations and different kinds of materials and structures as he wishes and obtain the answers, with a reduction of computing time at least 100-to-1 compared to longhand calculations on a small computer. Such performance calculations are being made on motors, transformers, turbine blades, and all manner of mechanical and electrical structures.

## DESIGN TO SPECIFICATIONS

THE SECOND STAGE is known as design to specifications and is illustrated in Fig. 6. In this case the program is so arranged that the designer can feed into the computer the specifications of the product to be designed. He has included in the program sufficient empirical information or rough formulas that the program can pick out an initial trial design on which to start calculating. The program than proceeds to calculate the performance constants as before. However, it then compares them with the specified performance values and proceeds to go back and make changes in the trial design and recalculate until the design meets the specifications. It is fairly obvious at this point that preparation of such a program requires a skilled designer. He is introducing into the program not only the design formulas that connect the physical structures with the performance, but also a great deal of his knowledge of the theory and workings of the particular device, which determines what to change in order to make the device approach the desired specifications. Also, only the designer knows in what order to make the changes so that in meeting the earlier specifications one does not introduce distortions into the design that make it necessary to change the whole thing when coming to the later specifications. Because of the iterative loops required to settle down on a design which meets the required specifications, a large number of computations may be required for a design of any complexity, and the high speed and low cost per unit computation of the high powered computer become almost essential, although some of this type of work can be done on the medium power computers.

This second stage, or design to specification, can be said to be optimized only to the limited extent that the design of any line of equipment is optimized. In establishing the line, the designers consider the various proportions and establish a general proportion which they feel to be most economic in view of the properties and cost of materials and available manufacturing techniques. Beyond this, the design method is established and individual designs to specification follow this general pattern. A designer may, however, use this type of design program to design several devices which meet the customers specification, but with different values of the nonspecified parameters, to determine the most economic of several alternatives. Also, he may design several alternatives to different specifications which can be offered to the user to show him the relationships of cost, weight, and size to the specifications which he issues.

## OPTIMIZING DESIGNS

IN THE THIRD STAGE, the program is set up to design the device to specifications, but to optimize the individual design in the process. The flow of calculations for this case is shown in Fig. 7. This problem may never be completely solved. A device with a number of specifications to be met, and, for example, 100 individual dimensions which can be varied, including material, types of connections, parallels of windings, etc., if 10 variations of each of the parameters are considered has 10 to the 100th power cases to be explored. This simply illustrates the impossibility of studying all the combinations on the computer to determine the optimum. Obviously, some better method needs to be devised, and the optimizing programs in use involve very ingenious devices for bringing the amount of computation into the range that can be economically handled on a high powered computer.

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As mentioned, this is difficult and limiting, and this phase of the design still stands to benefit greatly from further improvements in computer power in all directions. Between stage 2 and stage 3 lie many programs in which parts of the design are optimized, that is selected automatically by the computer according to principles of optimization, and in which the computer can be directed to search over ranges of the other parameters, either printing out each design searched, or alternatively, printing out the optimum for the variation of that particular parameter. Some of the stage 3 optimizing programs have been under development for the last two years.

## THE BUILDING-BLOCK APPROACH TO PHYSICAL SYSTEMS

In complex physical systems, calculations are generally in the first stage; namely performance calculations. As a matter of fact, it is only very recently and through the help of digital computers that such calculations have been possible at all. In other cases, simplified versions could be calculated but the system can now be treated in more refinement with the help of the digital computer. Such systems include the performance of a nuclear reactor, the mechanical vibration of a system of turbine blades, the aerolastic problems of a wing structure, that is the flutter problem, the digital solution of an electrical network or the calculation of a heat balance of a steam system.

## HEAT BALANCE OF A STEAM SYSTEM

In all of the cases cited, the building block approach is proving extremely effective and will be illustrated by a few examples. In the steam heat balance, there are some 40 different steam devices involved including turbines, condensers, heaters, pipes, inlet valve chambers, boilers, leakages, pumps, nozzles, etc. Not only are there 40 types of component parts but there may be several of each type; for example, several heaters. As handled in the IBM *704* computer program, the individual programs for these 40 different components are stored in 40 blocks of the magnetic drum as shown in Fig. 8. With each one is provision for data on several such components. Thus, for example, if a particular system had three heaters, three of the spaces associated with the heater program would be filled. Each one would give the characteristics of that particular heater and would also give the element that the output information affected from that heater calculation. This latter is called the connection information. Thus, once the specification of each part of the system has been read into the computer and the connection information that determines the connection of the system has been established, the system and its interconnections have been completely specified to the computer.

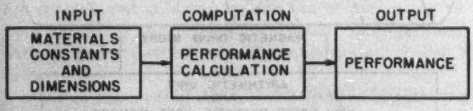


Fig. 5. Performance calculation.

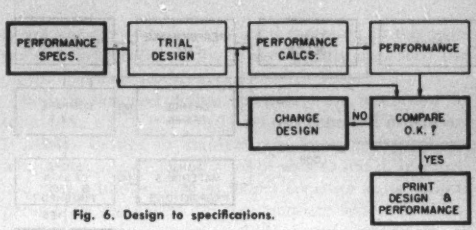


Fig. 6. Design to specifications.

The calculation then consists of starting from some assumed initial conditions, calculating the blocks one at a time until a complete iteration has been performed. The output of information from each block is then transferred to other blocks to which that information is input. The iterations are continued until steady conditions have been reached, corresponding to the heat balance of the system where heat input, output, and work of the system all balance. This is then the desired performance of the system.

## NETWORK SOLUTION

In the solution of an electric power network, the building blocks are busses. There are several kinds of busses as shown in Fig. 9. One is a load bus where the real and reactive power load are known. Another is a generator bus where the real power input is known and the voltage is to be held constant. Another is a generator bus at which the real power input is fixed and the voltage is to be held constant up to a given reactive power limit, after which the reactive is to be held constant. Another is a generator bus at which the real power is fixed but the reactive power is to be varied to hold the voltage constant at a particular load bus. Still another building block is a load bus at which the real and reactive power are specified and a transformer tap is to be changed to hold the bus voltage magnitude. Several other types of building blocks available in the program are illustrated in Fig. 9. Programs are written for these several kinds of building blocks, of which a few have been described. In this case, the program determines the new conditions at a particular bus with all of the other busses held constant at their last values. The iterations are carried out until steady conditions are realized and this is the answer; that is, the voltage and real and reactive power flows corresponding to the particular load flow conditions considered.

From these two examples, the generality of the building block technique may be observed. Although the two cases described both have discrete building blocks, continuous systems may be arbitrarily broken up into finite elements and treated as though discrete. Thus, each lattice point in a field problem may be considered as a discrete point acted upon by its neighbors as described by the finite difference equations corresponding to the differential equations of the system. Or else, a turbine generator may be divided into over 100 slices each having an inertia and elastic connections to its neighbors. These are then the building blocks used in determining the

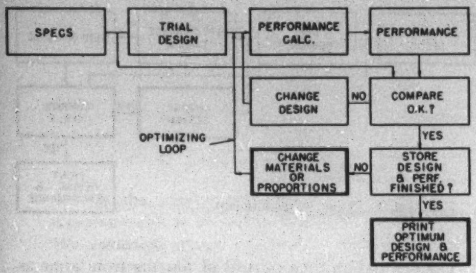


Fig. 7. Optimizing design program.

natural frequencies and modes of lateral vibration for this mechanical system. The simplification of this technique in considering only one element of the system at a time, and the equations relating it to the rest of the system, is fairly obvious both in providing a clearer understanding and providing a considerable degree of order to the programming job.

## UTILITY SYSTEM ENGINEERING PROGRAMS

WITH THE ADVANCES IN COMPUTERS and programming described in the foregoing, the digital computer now provides a powerful additional tool available to the system engineer. As an example, the following programs, complete or under development, now supplement the a-c and d-c network calculator and the ANACOM and electronic analog computers available as a service to all utilities, by the Westinghouse Electric Corporation in East Pittsburgh, Pa:

1. *Loss Formula:* A loss formula is determined from base and check cases and self–and mutual–impedance coefficients, and compares with check cases. A typical system requires 5 to 10 minutes on the IBM *704*.

2. *Self–and Mutual–Drop Coefficients:* This starts with branch impedances, determines self–and mutual–drop coefficients (general solution of the network), and is also for use in transmission loss formulas or for other problems. Running time on the IBM *704* from 5 minutes for a 24 bus system to 63 minutes for an 81 bus system (Fig. 10). Up to 200 bus systems can be handled.

3. *Economic Dispatch:* Economic dispatch is determined from station production cost curves and transmission loss formulas, taking one minute per dispatch, i.e., per system load or per delivered cost value, for a 20 bus system. Or, in general, 20 stations-times-dispatches per minute. Usually, dispatches are run at 15 to 20 loads for a family of dispatch curves.

4. *Load Flow:* Voltages and real and reactive power flows are determined from system impedances, transformers ratios, and specification of generator and load bus conditions as per Fig. 9.

5. *Transient Stability:* Swing curves are determined from admittance constants, machine inertias and initial conditions. (See also step 11, Determination of Admittance Constants, and step 4, Load Flow, for initial conditions.) Induction as well as synchronous machines can be included.

6. *Transient, Dynamic, and Steady-State Stability:* This is a digital representation of complete nonlinear differential equations of synchronous machines with voltage regulating and governing systems and power system equivalent representation and can be used for studying in detail the effect of machine parameters on various application considerations.

7. *Operating Costs of Alternative Plans:* Operating costs are determined including effects of losses and economic dispatching, broken down to significant parts, for multiple alternative plans of system development over a period of years.

8. *Transient Circuit Analysis:* Programs are available for analysis of transient cicruit problems. Example: Lightning protection of a generator connected to a system through a transformer.

9. *Heat Balance Calculation:* Heat balance of a steam system is determined from specification of parts and operating conditions. (See earlier paragraphs in the text.)

10. *Distribution Feeders:* This determines feasibility, ratings, locations and cost of alternative combinations of pole top regulators and fixed or switched capacitors to produce a required voltage control of a feeder of specified characteristics and load.

11. *Admittance Constants:* Admittance constants are determined (general solution of a network) from branch impedances, for use in stability studies or other power system problems.

12. *Short Circuits:* Short circuit currents and their distribution are determined, as well as voltages, from the branch impedances and specified voltages. Three-phase, line-to-line, and line-to-ground faults can also be determined.

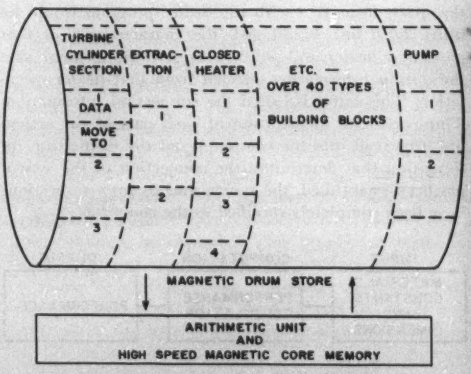


Fig. 8. Heat balance calculation on IBM 704 digital computer.

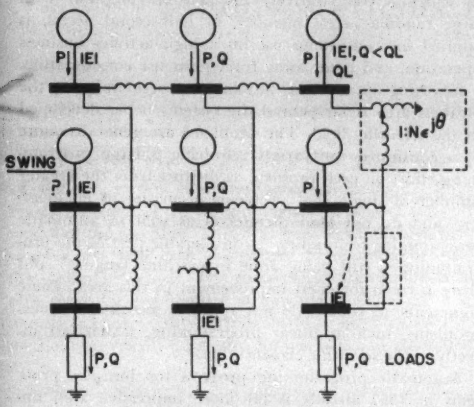


Fig. 9. Load flow building blocks.

In addition, numerous general mathematical programs and short specialized programs, such as $I^2R$ from branch currents and resistances are available.

The foregoing discussion has dealt only with one phase of engineering, namely, design and performance of the physical systems. However, to picture the breadth of the use of computers, a number of other topics must be treated at least briefly.

## ANALOG AND DIGITAL COMPUTERS

ANALOG AND DIGITAL COMPUTERS are now treated as largely complementary by informed engineers as opposed to the view of "analog vs digital" which has cropped up frequently in the past. Those concerns making the greatest use of digital computers in their engineering work are also found to be making the greatest use of analog computers and are finding substantial areas in which each device can provide more help and information for the effort and money expended than the other. Naturally, there are fringe areas that are continually changing and also which depend on the availability of computers of one type or the other. Analog computers are used most widely in regulating system analysis, in the study of electrical and mechanical transients on complex systems, in the representation of extensive nonlinear systems, in power system network solution and system planning operations, and in application studies of complex systems of machinery with their associated regulators. They are also widely used for thermal are aerolastic studies of aircraft and other structures. Many of the computers associated with automatic control, fire control, and guidance systems are of the analog variety including the economic dispatch computer used with the power system load and frequency control (Fig. 3 in Part I).

Many of the areas of digital computing in engineering have already been cited. Data reduction is quite distinctly a digital operation. Recent programs for differential equation solution by digital computer in the manner of a differential analyzer have greatly improved the digital approach in this area.

Both analog and digital computers are important in simulation which is divided into real time and otherwise. It may be desired to simulate completely a physical system by computer setup so as to be able to test it, in effect, and obtain information on its performance as its various parameters are varied. If the complete system is simulated by computer, a time scale transformation is, of course, permissible, doing the work in whatever time scale is convenient on the computer. However, in many cases, certain parts of the real system are not to be simulated but used in actuality, and it is then necessary to operate the computer, be it digital or analog, in real time to keep pace with the actual parts of the physical system included. There are also the problems of sensing devices to take information from the real system to the computer and of transducers to convert the answers back to suitable forces or movements. Simulation enters largely into the design of aircraft, autopilots, jet engines, missiles, etc.

The analog and digital computers are being connected together in a number of large simulation setups and have required the development of analog-to-digital converting equipment of high accuracy to make this practical.

Another extensive engineering field is the information processing of the huge quantities of data taken from the wind tunnels or field tests of various kinds. The large quantity of such information and the necessity of reducing it rapidly to useful form to guide further tests, or the necessity of reading very rapidly to obtain the maximum amount of information in the smallest time in an expensive test facility, are the motivating influences back of these very extensive information processing systems.

## COMPUTERS IN BUSINESS AND MANUFACTURING

DURING THE LAST YEAR OR TWO, large-scale electronic computers have crept into all major industries on the American scene. They are now in use, usually for both business and engineering purposes, in motors, steel, electric utilities, electrical manufacturing, chemicals, oil companies, aircraft companies, Government bureaus, development laboratories, research institutions, banking, and insurance, to mention but a few. The true story of this expansion may not be known for a few years, for, after the initial flurry of placing the more obvious payroll and inventory problems and the billing and accounting functions on computers, many companies are quietly at work extending the use of these facilities to many other more difficult but extremely rewarding applications. Application to the huge problem of customer billing and accounting is, of course, of primary interest to the electric utility companies. Payroll, purchasing, and inventory and stores accounting are also important fields of application.

With respect to the machines themselves, originally developed along separate lines for business and scientific purposes, two seemingly contradictory trends are now evident. One is the definite trend toward a common com-

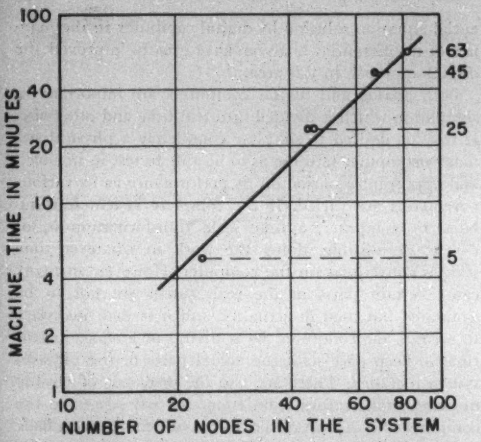


**Fig. 10. Approximate time to obtain self- and mutual-drop coefficients using a complex double precision matrix inversion program on the IBM 704.**

puter or computing center which has the proper complements of equipment to meet all of the large information processing requirements of a plant or group of plants. Originally, it was felt that the large input–output requirements and special storage requirements of the business problem required a separate type of machine from the engineering problems, with their comparatively smaller input and output and very much greater computational requirements. However, it has since been found that even though the input-output of the engineering problem is small relative to the business problem, it still may require half of the total computing time and, thus, economically justifies high speed input–output equipment, the same as the business problem. Thus, this distinction between the two is being obliterated rapidly.

Programmers of both business and engineering problems are finding that a large high speed memory is extremely advantageous and time saving in the programming of problems of either kind and, thus, this requirement for an expensive element of the machine suggests the pooling of both problems on a single facility with very ample high speed memory.

The supposition of low computing requirements of the business problem are based on compatibility with input–output speed. However, buffered computers with multiple tapes may raise the input–output speed to where business problems, as well as engineering problems, can profit from the lower unit cost per computation with a higher speed computer. Thus, new computers are coming out with remarkably improved abilities for handling the combined loads of engineering and business problems.

Quite distinct from this trend is the appearance of on-line data processing equipment such as the IBM *Ramac* in which a comparatively inexpensive computer with large random access memory, of half-second access, is applied for continuous use on a high activity business operation, and tends away from joint use consideration.

Anything approaching automatic programming in the business area is far behind the systems being developed in the scientific field. The problems are generally more of a continued use variety requiring a large programming effort on each problem as distinct from the greater number of single shot problems occurring in engineering, and do not lend themselves as well to automatic programming techniques. A considerable part of the programming is still being done in machine language and there is room for great improvement in this area. These comments, of course, do not apply to scientific business problems, such as linear programming, which fall directly in the scientific classification.

Automatic programming progress for business problems in 1957 already is far more impressive and, undoubtedly, the next few years will see extensive use of these new methods. This progress has arisen from a recognition of a definite distinction between those operations which differ from plant to plant and from business to business and those more general operations like sorting, merging, etc., which can be provided as subroutines in automatic programming.

The foregoing paragraphs, stressing the applications of computing devices to business, engineering, and science, have failed to mention huge sections of information in Government, weather, astronomy, medicine, language translation, and military science in which work is going on. However, enough has been mentioned to explain the appearance on the scene of a large new industry and several new professional organizations with thousands of members and huge activities in the existing professional organizations devoted to this area.

Most significant of all is the breadth of base of this movement, sparked by a few tiny (relative) scientific and military applications only a decade ago, and now grown into every avenue of human enterprise in so short a time. This is coupled with the known fact that the key which has unlocked this door, the high speed digital computer and its ever increasing circle of accessories, is increasing in power at just as high a rate as it ever has, and shows every prospect of continuing this for an indefinite number of years ahead.

## CONCLUSIONS

IT WAS PROPOSED at the beginning of this article that man's work can be divided into mental and physical categories and that information processing bears the same relation to man's thinking process or his mental work as the application of physical power to his physical work. It is to be expected, therefore, that the implications of information processing are quite as far reaching as power and that the tremendous stimulation to automatic processing provided by the digital computer is producing nothing less than a revolution in this area. Some call it a second industrial revolution. It is hoped that engineers can keep this one under better control than the last one.

# Eddy Currents in End Windings

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MEMBER AIEE

THE PROBLEM of calculating eddy-current loss in the end portion of turbine-generator stator windings involves a study of the three-dimensional field of the end region of the machine. This field may be subdivided into components, and each component determined by two-dimensional methods. The components are combined to give the total flux density at any point. Once the flux density is known, eddy-current loss may be calculated by methods previously developed for bus bars and laminated cores.

Eddy currents in the end portions of stator windings are caused by flux in the end portion of the machine, that is, beyond the stator slots, linking the stator coil ends. A study of the magnetic field in this region is a complex three-dimensional problem. The problem is, however, capable of solution if the field is first broken down into subdivisions representing the various portions of the current-carrying conductors and the fringing of the main air-gap field, and then considering the components of these subdivisions in both the circumferential and radial directions.

The physical center lines of the slanted portion of the stator coil ends lie on skewed lines along the surface of two concentric cones coaxial with the rotor shaft. These cones may be replaced with good approximation by two concentric right circular cylinders coaxial with the rotor shaft for each of the points at which flux density is to be calculated.

The cylinders representing the actual cones may be developed into two parallel planes, and the simplifying assumption of replacing all coil sides in a given phase belt with a single current sheet passing through their physical center lines may be made.

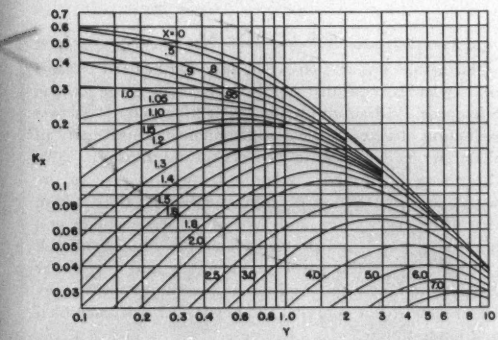


Fig. 1. Coefficient for flux density parallel to a current sheet (in the x direction). $H_x = -K$ crest ampere-turns per centimeter.

The components of flux density at any point due to each of these current sheets can be calculated from curves such as those given by Fig. 1. Similar current sheets are used to calculate the flux density resulting from current in the straight portion of the stator coil ends, from current in the circumferential portion of the rotor coil ends and

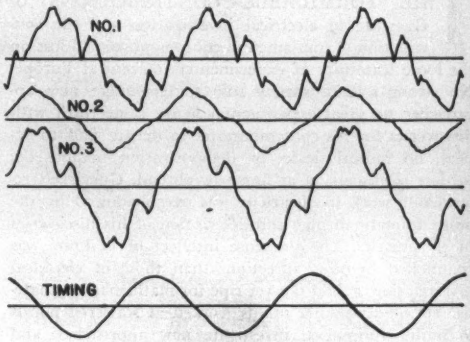


Fig. 2. Zero power factor oscillogram.

from current in the axial portion of the rotor coil ends. Flux density resulting from fringing of the main air-gap field can be calculated by methods previously developed.

Once the flux density at any given point on the stator coil ends is known, the eddy-current loss per unit volume of copper at that point for the particular flux density can readily be calculated. The eddy current loss in watts per cubic centimeter is

$$\sqrt{\frac{f}{\lambda}}\,\frac{H_0^2}{8\pi 10^7\, a}\left(\frac{\sinh 2\pi a\sqrt{f\lambda}-\sin 2\pi a\sqrt{f\lambda}}{\cosh 2\pi a\sqrt{f\lambda}+\cos 2\pi a\sqrt{f\lambda}}\right)$$

To provide experimental verification, search coils were placed on the end portion of a neutral coil side adjacent to the gap on the outboard end of a 3,600-rpm generator rated 60 mw at a hydrogen pressure of 0.5 psig. Fig. 2 is an oscillogram taken during synchronous motor operation. The synchronous motor test shows good correlation between test and calculated values of flux density.

Digest of paper 57-127, "Eddy Currents in the End Portion of Turbine-Generator Stator Windings," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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# Early Electrical Machines

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**This is the third article of a series on pioneering investigations in electrical science. Investigations into the nature of electricity increase in tempo with the first demonstrations on men and machines hinting at the enormous power inherent in this phenomenon.**

THE FORMIDABLE CONTRIBUTIONS of Guericke in electrical investigation and the construction of fundamental equipment seemed lost on the loose fraternity of experimenters of central Europe. No strong science society rose to encourage new approaches, no great experimental figure came forth with discoveries for his contemporaries to debate and to repeat, no radical device or demonstration became the subject of discussion at home or abroad. Guericke's remarkable work in electricity was over-shadowed by the more dramatic display and description of his discoveries in pneumatics. The immense intellect of Leibnitz was channelled in other directions than those of electrical investigation, a field not yet ripe for mathematical analysis. Yet many smaller minds worked at scattered points to build equipment, investigate new approaches, and publish their results in scattered pamphlets and obscure journals. It was in the decade from the mid 1740s to the mid 1750s that their cumulative work was most telling.

Among this group of investigators, Georg M. Bose (1710-1761), professor at the University of Leipzig and later of Wittenberg, preferred the promise of the rotating glass globe of Hauksbee to the simplest glass tube as a source of electric charge. By applying the continuous charging ability of the rotated Hauksbee globe to a strung line, the magnitude of the charge was considerably increased and held.

Bose, in 1743, issued three small tracts in Latin (one was a poem) in which the virtues and mysteries, including the art of making an electric halo, were described. He lined up 20 soldiers with hands touching, and shot an electric discharge through them all at once. At a time when fire was still one of the four basic elements, Bose drew his sacred flame from his audience, and in impressive streams from banquet tables loaded with silver dishes, flowers, food, and tableware. The tables were set on bituminous cakes and the generator was in an adjoining room, to intensify the wonder. Pretty girls welcomed all to come and touch them or to kiss them with the reward of a shock that Bose boasted "broke their teeth."

Dr. William Watson, who was among the most active experimenters and discoverers in early electricity, repeated Bose's experiments and forced Bose to admit that the halo effect was produced only on one wearing concealed armor and that Bose's boast that he could shock a whole army had its limits.

Watson performed many electrical demonstrations. One of his electric systems is shown in Fig. 1. It comprised the generator C turned by a wheel and crank. The charge, caused by a dry hand, is drawn by the feet of the boy suspended by silk ropes, and transmitted to the girl standing on a tub of dried pitch, whose hand attracts and repels some chaff H. At the upper left are two bells, and a clapper hung from a silk thread. A charge drawn from the electrified gun barrel T causes alternate attraction and repulsion of the clapper and a "jingling of the two bells."

The exciting experiments with men and machines could not go very far before someone would suggest applying electricity to the human body as a curative agent. That one was Christian G. Kratzenstein (1723-1795), of Halle, who first applied electricity to observe its physiological effects. On administering a charge to a person, Kratzenstein observed an increase in the pulse beat and acceleration of the blood circulation and a contractile effect on the muscles. He then began to administer electric charges in cases of such congestive ailments as rheumatism, malignant fever, and the plague, and claimed to have cured the lame or stiff finger of a woman in 15 minutes. Other experimenters turned to applying electrifying charges and sparks to alleviate human suffering.

In nearby Biala, Poland, Gottfried H. Grummert proposed the use of rubbed, exhausted glass tubes for work in mines as a source of light, for in such places ordinary fire and light could not be used. It was a promising suggestion, like so many others, but hardly the complete solution to the problem of a miner's safety lamp.

## THE LEYDEN JAR

TRADITION HAS IT that when the stouthearted citizens of Leyden successfully repulsed the long siege of the Spaniards, William of Orange, their king, offered them a reduction of taxes or the establishment of a university in their city. They chose a university and thus, in 1575, there was established a school that was to give to the world so much that was good and useful. It was here that Guericke studied and Willem J. 'sGravesande and his former pupil and protégé Pieter van Musschenbroek (1692-1761), professors of mathematics and physics at Leyden, taught and inspired a generation of worthy Dutchmen. It was here that the Leyden jar was assembled and made public.

In a letter to René de Réaumur in Paris written in January 1746, Musschenbroek described his experience

Partial text of "Early Electrical Machines," published by the Burndy Library.

Bern Dibner is president, Burndy Corporation, Norwalk, Conn.

with a novel arrangement of parts that had a most impressive effect upon him. Musschenbroek wrote "I wish to inform you of a new but terrible experiment, which I advise you on no account personnally to attempt. I am engaged in a research to determine the strength of electricity. With this object I had suspended by two blue silk threads, a gun barrel, which received electricity by communication from a glass globe which was turned rapidly on its axis by one operator, while another pressed his hands against it. From the opposite end of the gun barrel hung a brass wire; the end of which entered a glass jar, which was partly full of water. This jar I held in my right hand; while with my left I attempted to draw sparks from the gun barrel. Suddenly I received in my right hand a shock of such violence that my whole body was shaken as by a lightning stroke. The vessel, although of glass, was not broken, nor was the hand displaced by the commotion: but the arm and body were affected in a manner more terrible than I can express. In a word, I believed that I was done for." An experiment by Winkler similar to the one described by Musschenbroek is shown in Fig. 2.

Musschenbroek noted that it was essential either to hold the jar in one hand and draw sparks with the other, or to place the jar on a metal plate on the table, the experimenter touching the plate with one hand and holding a finger of the hand near the brass wire leading from the gun barrel to the jar. He also discovered that the thinner the glass, the more effective the discharge.

Concurrently (as so often happens) with the work of Musschenbroek of Leyden, another amateur experimenter, Ewald G. von Kleist, dean of the cathedral at Cammin in Pomerania, on November 4, 1745, sent an account of some significant electrical experiments he had completed a few weeks earlier to Dr. Lieberkuhn in Berlin. Kleist considered his message so important that he repeated its substance in messages to several other investigators in Halle, in Danzig, and to Winkler.

Winkler disclosed Kleist's device as a means for storing and delivering a very powerful electric shock. The arrangement of parts of this device consisted of a nail driven into a wooden spool upon which a wire had been

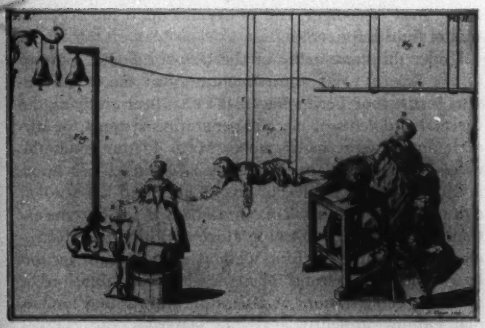

Fig. 1. One of Dr. William Watson's experiments in electricity.

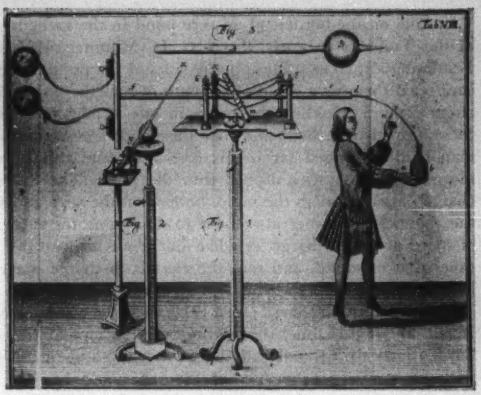

Fig. 2. The earliest illustration of the Leyden jar, 1746.

wound. This assembly was then inserted into a glass flask containing a little alcohol or mercury. When the nail was electrified a flaming shaft of light shot forth which continued while Kleist managed to walk 60 steps. He could charge his apparatus in one room and walk into the next room to ignite a container of alcohol. He found that the flask would hold its electrification for 24 hours. Most important was Winkler's realization that to be effective it was necessary that the flask be held in the hand.

Of the two elements of novelty in this device—the part played by the hand and the body, and the ability to hold a charge for an extended period—it was the philosophic potential of the body's relation to electricity that offered the greatest speculative concern to Kleist, a clergyman. It was the very importance of the contact of the hand with the flask that Kleist had failed to communicate clearly to his contemporary experimenters. That resulted in the uncertainties of assigning priorities to him for the discovery of the condenser, or the means for storing an electric charge. Winkler improved the Kleist jar by winding a chain around bottle, leading it to a metal plate and thence to the prime conductor of his multiple-globe generator. The shocks resulting from this equipment caused him, he claimed in a letter to the Royal Society, convulsions, blood-agitation, and fever.

Support to priority of discovery of the Leyden jar by Musschenbroek is given by both Winkler and Watson. In Watson's book, for example, published in 1746, he wrote, "I now proceed to take notice of that surprizing effect, that extraordinary accumulation of the electrical power in a vial of water; first discovered by professor *Musschenbroek*, a man born to penetrate into the deepest mysteries of Philosophy."

To the means for generating electricity there was thus added a device for accumulating or storing one or more charges, a condenser which extended the range of operation. By adding conducting elements, there was created the beginning of an electric circuit. Continued experimenters reduced the need of the body in the circuit.

In 1746 on the borders of an acre pond in the gardens of the Tuileries in Paris, Pierre C. Le Monnier (1715-1790), placed two men on opposite sides of the pond and connected them by a chain of a length of half the pond's circumference. Holding the chain in one hand, one of these dipped his other hand into the pond. The second man held a charged jar in his free hand and this he moved towards a wire dipped into the pond. The discharge passed through the pond, both men, the wire and the chain. Le Monnier attempted to determine the rate of speed of the discharge, decided that it was at least 30 times that of sound, and that the electric discharge was held by a body in proportion to its surface; not its mass.

It was Dr. John Bevis (1693-1771), F.R.S., who suggested, about this time, that if the outer surface of the Leyden jar were covered with a thin sheet of lead or tin foil, the storative properties of the jar would be improved. It was then shown that the equivalent effectiveness was proportional to the surface covered and that the whole hand was not required to cover the jar, as with an uncoated jar; just touching the foil with the wire served equally well. He also arranged a glass plate with foil on each surface which acted as an accumulator of electric charges, the earliest plate condenser.

Two specific conditions regulating the strength of an electric discharge had, by now, been determined by Musschenbroek and by Watson: the thinner the intervening glass between the metallic coatings and the larger the area of the coatings, the stronger the shock. In addition, the same Dr. William Watson (1715-1787) had defined in 1747, the characteristics of the outer circuit or path of a charge from one jar's surface to the other as being the shortest possible, and along the material best conducting electricity, no matter if this meant a longer path. He extended Le Monnier's traverse of the Tuileries pond by making a circuit of 1,200 feet across the Thames and over a wire on the Westminster Bridge in July 1747. Later he tried a 2,400 foot circuit, and at Stokes-Newington an 8,000 foot circuit was tried, with the conclusion that the earth could be as good a conductor as the river's water. He extended his trials to a four-mile circuit in order to determine the speed of travel of the electric fire but could refine the results no better than "nearly instantaneous."

(The next issue will carry an account of further experiments in the development of the Leyden jar and of the significant contributions of Benjamin Franklin to general electrical knowledge.)

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# Thermal Considerations of Generators in High-Speed Aircraft

ALEXANDER KUSKO
MEMBER AIEE

**The problem of providing effective cooling of electric power equipment in aircraft becomes more acute as flight speeds and altitudes increase. Present trends in generator design are to introduce new high-temperature materials, to employ a circulating coolant and an external heat exchanger, and to depend upon the evaporation of liquids for cooling.**

THE PROVISION of electric power in aircraft becomes increasingly difficult as the speed and altitude of flight increases. The relatively large values of electric power generated per pound of equipment in subsonic aircraft are achieved by employing the low-temperature environmental air, directed as a blast through the generator, to remove the generator heat losses and limit the internal temperature. As actual and projected flight speeds increase, the air blast becomes less effective as the cooling medium, because the stagnation temperature of the air approaches and exceeds the allowable temperatures of the insulating materials, bearings, and brushes of the generator. To handle the cooling problem, the present trends in generator design are to introduce new materials which are able to operate at higher temperatures, to employ a circulating coolant such as oil and an external heat exchanger, and to depend upon the evaporation of liquids for cooling.

Under the sponsorship of the U.S. Air Force, a group in the Energy Conversion Laboratory at the Massachusetts Institute of Technology (MIT) has been studying the thermal problems of electric generating systems for aircraft operating at speeds up to Mach 4, four times the speed of sound or approximately 2,700 miles per hour, and altitudes up to 100,000 feet. The group has studied two phases of the problem. One phase is the determination of the maximum temperature at which the electromagnetic rotating-machine method of energy conversion is feasible. The second phase is the determination of optimum combinations of generators and cooling systems that employ presently available materials and components.

## PROBLEMS INTRODUCED BY HIGH-SPEED FLIGHT

THE BASIC THERMAL PROBLEM of electric generators in high-speed aircraft, based upon extending the techniques presently used at lower speed and altitudes, is the rapid rise with speed of the stagnation temperature of air taken on board as a heat sink for generator losses. The stagnation temperature of cooling air at four flight design points is shown in Table I; note that the temperature rises from a value of 27.7 C at Mach 1 and 30,000 feet altitude, to 724 C at Mach 4 and 100,000 feet altitude. Materials employed in aircraft generators must be capable of operating at temperatures above the stagnation temperature of blast air if the air is to serve as a heat sink.

By comparison with the stagnation temperatures of blast air over this flight range, the maximum temperatures at which typical materials and components can be operated in aircraft generators today are shown in Fig. 1. It is interesting to note that insulating materials, which are available and capable of operating at temperatures of 250 C, no longer set the temperature limits of the machine; silicon rectifiers and bearing lubricants are now limiting internal temperatures to the range of 125 to 150 C. Of course, development work is continuing on dielectric materials, bearing lubricants, rectifiers, and other components, so that in time the maximum internal temperatures will certainly be permitted to increase. However, a comparison of the temperatures limits shown in Fig. 1 with the data given in Table I shows why blast cooling will be limited to the Mach 2 to Mach 3 flight region in the near future.

Should blast cooling be unsuitable, a number of alternate methods appear for transferring the generator losses to a heat sink. However, these proposed methods may exact a large penalty from the aircraft performance just to provide generator cooling. Fig. 2 shows a set of curves relating the percentile decrease in maximum range of a typical aircraft to the sum of the dead weight plus the weight equivalent of the drag imposed by the cooling system. The optimum system for a flight design point or flight profile is the system that imposes a minimum overall penalty on the aircraft performance, as measured by a comprehensive penalty-factor method.

## GENERATING SYSTEM DEVELOPMENT

IN THE FACE OF RISING stagnation temperatures of blast air, several approaches can be followed to achieve generating systems for high-speed aircraft. The development of higher-temperature materials and components will result in a gradual increase with time of the maximum speed–altitude design point at which blast cooling can be used. The higher machine temperatures will also reduce the temperature differential through which an external cooling system must carry generator losses to an arbitrary heat sink; that is, an increase in internal machine temperatures will simplify and reduce the weight of external cooling systems for generators.

A second approach to the development of generating systems for high-speed aircraft is the introduction of so-called environment-free machines. These machines utilize an evaporating liquid as a heat sink, with the liquid either directly inside the machine or in an associated water boiler. The weight of these cooling systems is proportional to flight time. Furthermore, they introduce certain other problems that limit their application as a long-range solution to the power generation problem. An essentially environment-free system that shows great promise is one employing engine fuel as the heat sink for generator losses; the fuel may be retained in the liquid state in passing through the heat exchanger, or permitted to change to the vapor state.

A third approach to generator cooling is the use of ram air, which is obtained either as blast air, or engine-compressor bleed air, as the heat sink for generator losses. The ram air is utilized for direct heat transfer by processing it with expansion turbines and heat exchangers to lower its temperature below the maximum allowable temperature of the generator, or by employing a refrigeration system for transferring generator losses up to the

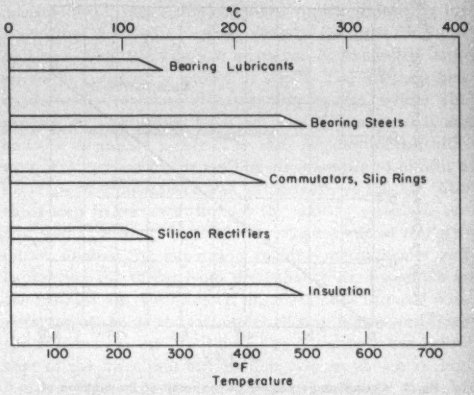


**Fig. 1. Temperature limits of presently available materials and components for generator construction.**

**Table I. Stagnation Temperatures for Four Design Points, Based Upon Standard Hot Atmosphere**

| Speed, Mach no. | Altitude, feet | Stagnation Temperature, degrees | |
|---|---|---|---|
| | | Centigrade | Fahrenheit |
| 1 | 30,000 | 27.7 | 82 |
| 2 | 50,000 | 146 | 295 |
| 3 | 70,000 | 380 | 716 |
| 4 | 100,000 | 724 | 1335 |

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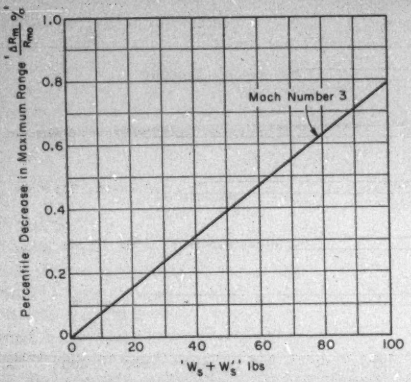


**Fig. 2. Aircraft range penalty as the result of the addition of a cooling system. (Per-cent decrease in maximum range is plotted against the sum of cooling system dead weight $W_s$ and the dead-weight equivalents of drags imposed by the cooling system $W_s'$. Based on an empty aircraft weight of 10,000 pounds.)**

temperature level of the ram air. While the refrigeration system appears to be comparatively heavy, the ram-air processing systems are comparatively light and appear promising for high-speed aircraft. The ram-air processing system has the further advantage that generators designed for conventional blast-cooling operation can be inserted directly into these systems without further development.

## MATERIALS CONSIDERATIONS

ELECTRIC-POWER GENERATING EQUIPMENT is synthesized from a combination of magnetic, dielectric, conducting, structural, and lubricating materials. Each of these materials suffers a downgrading in characteristics with increased temperature; some are more critical at this state of the art than others. Magnetic materials undergo a decrease in magnetization with increase in temperature, which culminates in a loss of ferromagnetic property at the Curie temperature. Typical Curie temperatures are approximately 750 C for iron and 1,100 C for cobalt.

The deterioration of dielectric materials with temperature is well known, and results in loss of both mechanical and dielectric strength. The presently available pliable dielectric materials are limited in temperature to about 260 C for the silicons, although Teflon can be operated above 300 C under certain conditions. In order to reach insulation operating temperatures of 1,000 C and more, ceramic-type materials must be employed at the present time. However, these materials are solid, not pliable, and may require a new philosophy of machine design and construction for their use.

Two problems are encountered with conducting materials for high-temperature operation. First, the increase in resistance with temperature causes an increase in $I^2R$ loss and a more difficult cooling problem. For example, copper has twice the resistance at 235 C that it has at zero C. The second problem is a tendency for surface oxidation of the copper to produce additional high resistance. Techniques such as nickel plating the conductor have alleviated this problem.

The temperature limitation of structural materials does not appear so markedly in the range of temperatures encountered for generator operation. The structural materials probably cause more difficulty over the required wide-temperature range because of bearing fit and thermal shock, rather than because of strength at a steady-state temperature. Lubricating materials are a present limitation in the maximum permissible temperature of generators. New types of lubricants and bearing systems are being developed to raise this temperature limit.

Should improvements on insulating materials and lubricants permit generator temperatures to be raised designwise, then the temperature effect on the magnetic materials (Curie point) will start affecting the size and rating of high-temperature rotating generators. The decline in the saturation flux density of the ferromagnetic material as its temperature approaches the Curie point requires that the magnetic-circuit cross-section be increased to obtain a given generator rating with temperature. An example of how generator weight can be expected to increase with temperature, because of the magnetic-circuit requirements, is shown in Fig. 3. Obviously, the development of ferromagnetic materials with higher Curie temperatures is necessary to conserve weight of high-temperature machines.

Since the improvement of materials and techniques has permitted the maximum operating temperatures of aircraft generators to increase with time at a slow and expensive rate, it is interesting to note the effect of this increase on the flight regions of generator application to aircraft. In Fig. 4 are shown the steady-state operating regions in the altitude–speed plane of blast-cooled Class C and Class D generators. The Class C generator is designed to operate with a maximum inlet air temperature of 120 C and the Class D at 250 C. The Class D generator

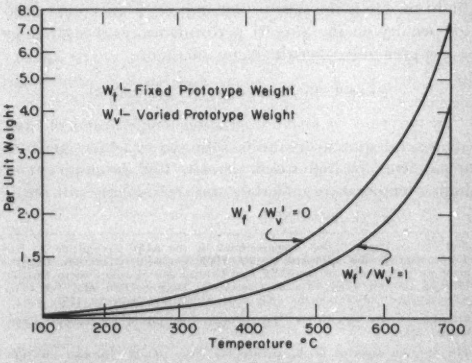


**Fig. 3. Per-unit weight of an aircraft generator vs temperature for a Curie temperature of 740 C. ($W_v'/W_f'$, is the ratio of those weights which must change with temperature, such as iron, to those which remain fixed, such as bearings, etc.)**

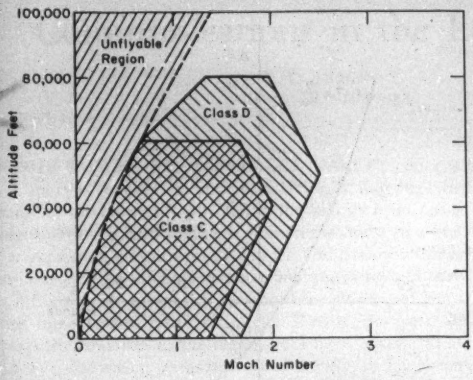


**Fig. 4. Operating region of blast-cooled Class C and Class D generators.**

is not yet available from industry. Although the Class D generator will represent a major design step in maximum operating temperature, the resulting enlargement of the steady-state operating region of aircraft equipped with this blast-cooled generator is very moderate. For example, the blast-cooled Class C generator can be operated in aircraft up to a speed of Mach 2 at 40,000 feet, with a maximum altitude limitation of 60,000 feet; the Class D generator, on the other hand, can be operated in aircraft up to a speed of Mach 2.5 at an altitude of 50,000 feet, with a maximum altitude of 80,000 feet. However, the use of a higher-temperature generator will reduce the weight and complexity of an external cooling system, should one be necessary, and will also reduce the drag imposed on the aircraft when the generator is blast cooled.

## EXTERNAL COOLING SYSTEMS

THE ALTERNATIVE APPROACH to developing high-temperature direct-blast air-cooled generators is to utilize generators of presently available materials and to design for them external cooling systems for transporting their electrical losses to a preselected heat sink. The present trend in generator design, where stagnation temperatures and other factors do not permit direct-blast cooling, is to employ a circulating-oil system in which the oil carries the heat from the generator to an external heat exchanger. This approach does not solve the fundamental cooling problem, but transfers the problem from within the machine to outside the machine. The maximum temperature of the cooling oil is limited by the maximum permissible temperature of the generator and by the properties of the oil itself. The circulating-oil system does permit the design of a more compact generator and integration with the constant-speed drive, but it also introduces many problems of a mechanical nature. Heat can also be transported to an external heat sink by a closed-cycle refrigeration system. Suitable heat sinks for such systems are processed ram air, fuel, and evaporants.

Processed ram air can be applied directly to generators designed for blast cooling without the use of an intermediate fluid; hence, these systems appear promising for extending the flight regions already suitable for blast cooling.[1] The development sequence of expanded ram-air cooling systems is shown in Fig. 5. The diagram first shows a conventional blast-cooling system where the cooling air is supplied from an inlet diffuser and is exhausted through a nozzle. The next step shows the addition of a turbine for expanding the ram air to obtain a decrease in temperature and in pressure of the air. The third step in the evolution of the cooling system is the addition of a compressor on the exhaust side of the generator to load the expansion turbine mechanically and to increase the thrust from the exhaust air. Inasmuch as the exhaust air is limited to the maximum internal temperature of the generator, under certain flight conditions the exhaust air may be limited to a temperature below that of the inlet ram air. In that case, as shown in Fig. 5 (d), a regenerative air-to-air heat exchanger may be profitably added to the system. The final cooling system topology shows the addition of a second turbine on the same mechanical shaft as the first two turbines in order to utilize the generator exhaust air more effectively.

These expanded ram-air systems appear so promising for generator cooling, particularly at the Mach 3 design point, that they were studied in detail and optimum design conditions found. The system shown in Fig. 6 is an optimum expanded ram-air system for Mach 3 operation at 70,000 feet altitude of a single 40-kva generator. A more complicated system for operation at Mach 4 and 100,000 feet altitude with a 40-kva generator is shown in Fig. 7. The optimum parameters were obtained by programming the design of these systems on a high-speed digital computer (MIT Whirlwind Computer) and selecting parameters that resulted in the smallest range-penalty factor.

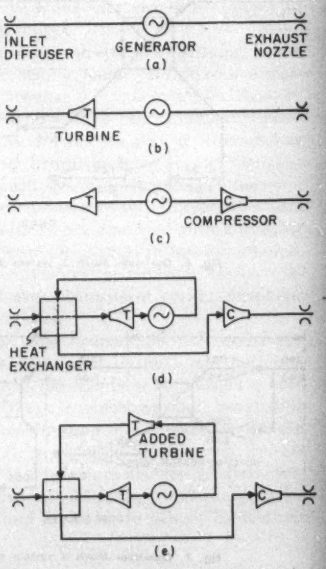


**Fig. 5. Development sequence of expanded ram-air topology.**

Although it is possible to optimize a cooling system for minimum penalty factor, it is more logical to optimize the combination of the generator and the cooling system. It is well understood that the loss and weight of a generator are interchangeable in a design sense. Such a relationship is shown in Fig. 8 as the change in loss and the change in weight from standard conditions of a Class B 40-kva aircraft alternator. This loss–weight relationship was determined with a digital computer on which the design of the generator was optimized with respect to weight for perturbations in dimensions and losses above and below the standard design. For example, the computation shows that an increase of loss of 1.2 kw results in a saving of generator weight of 15 pounds. Since expanded ram-air cooling systems appear to accommodate an increase in power-loss capacity without a proportional increase in weight, an optimum system may consist of a generator having greater losses but lighter in weight than the existing blast-cooled machine and the appropriate expanded ram-air cooling system.

## CONCLUSIONS

By employing ram-air processing equipment, it appears that existing aircraft generators can be operated over the range of flight speeds from Mach 1 to Mach 4 and appropriate altitudes, within acceptable penalty factors to the aircraft. The raising of maximum temperatures of generators by using new materials and components will reduce penalty factors to aircraft but will not markedly extend the flight regions in the speed–altitude plane for blast cooling. Extensions of the flight region

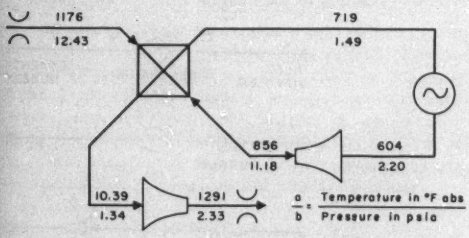


Fig. 6. Optimum Mach 3 system parameters.

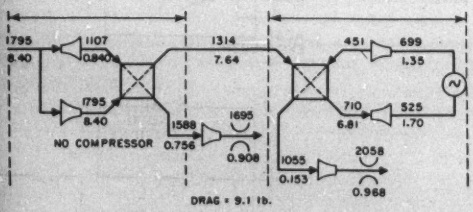


Fig. 7. Optimum Mach 4 system parameters.

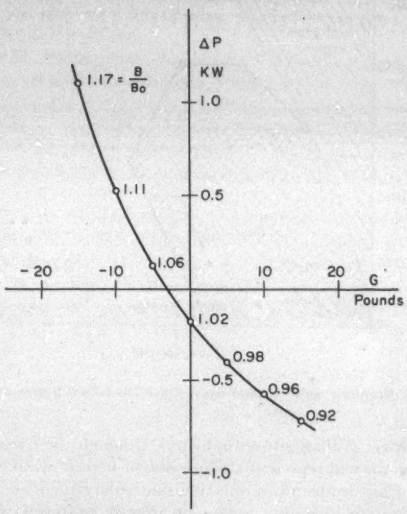


Fig. 8. Change in loss as a function of change in weight for an aircraft generator.

will certainly require some type of auxiliary cooling system for the generator or for the group of components of which the generator is a part.

The recommended method for cooling generators for flight speeds from Mach 1 to Mach 2 is blast cooling, using either the presently available Class C type, or the anticipated Class D type, which is to operate with an inlet air temperature of 250 C for Mach 3 aircraft operation, the expanded ram-air system shown in Fig. 6 is recommended: this system will impose a theoretical additional penalty of 35 pounds of dead weight and 7 pounds of drag on the aircraft for a 40-kva generator. For Mach 4 operation, the expanded ram-air system shown in Fig. 7 is probably too complicated; hence, either evaporative cooling is recommended or the development of fuel-cooling systems is urged. Because the technology of expanded ram-air cooling systems is not well developed, further work, particularly on off-design operation, is needed.

The auxiliary cooling system of most promise for high-speed flight appears to be that employing fuel as the ultimate heat sink. The system has limited capacity if the fuel remains in the liquid phase; however, the system is very promising if the fuel is allowed to vaporize in the heat exchanger so that the latent heat of vaporization is utilized. Finally, it appears that the ultimate solution to the problem of generating electric power in high-speed high-altitude vehicles is the development of new energy-conversion processes that can employ existing materials more effectively in the high-temperature environment that is encountered.

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# Communications in the Lower St. Lawrence Valley

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THE LOWER ST. LAWRENCE VALLEY, once a sparsely populated area with villages hugging the shore of the river and gulf and living mainly from farming, lumbering, and fishing, is now in the midst of a major expansion program. Iron, copper, and titanium mines are exploited, numerous factories are appearing and over a million horse power has recently been developed from the huge hydroelectric resources. During the past 20 years the resources of the region have been developed at an ever-increasing rate and consequently it has been necessary to extend communication facilities to keep apace with this industrial development.

Québec-Téléphone provides telephone, private wire, and message telegraph service in the area. The Canadian National Telegraphs with their communication facilities along the railway provide leased wire service, broadcast program transmission, telegraph service, and facilities for railway operations. At some points, the latter company operates joint telegraph offices with Québec-Téléphone. The Quebec North Shore and Labrador Railway provides telephone and telegraph service along its route between Seven Islands and Knob Lake. Québec-Téléphone interchanges traffic with neighboring companies.

The telephone system is being modernized and extended in accordance with the technical requirements of the continent-wide direct distance dialing plan. Local manual offices are converted to dial service with the following features:

(1) Terminal per station instead of terminal per line is provided in all offices to improve intercepting and economize on central office codes.
(2) Intercepting of every vacant, disconnected, or changed number and vacant selector levels is provided by an operator at the toll center. In large offices, this is done on a special group of trunks but in a small office intercepted calls are routed over regular traffic circuits.
(3) The directory number of every telephone consists of the first two letters of the office name and five digits. It is considerably more economical to provide digit absorbing switches than selector stages for all seven digits. The equipment installed is of the step-by-step type. Toll trains are provided to return standard flashes and tones. New dial telephones are equipped with dial number plates with letters and numerals.

One primary and four toll centers have been assigned in the region. These switching centers are surrounded by a cluster of community exchanges which, under the final plan, will be unattended dial offices. Each office will have direct trunks to a *3C* switchboard at its toll center, providing better transmission and faster service.

New construction of subscriber lines is planned in accordance with the new "resistance" design. Substantial savings and improved transmission have resulted from the use of these new practices; e.g., smaller gage cable conductors, and conservation of engineering time. To preclude use of more than one gage of conductor in the same cable and to keep the resistance within requirements, a subscriber's loop may consist of sections of 26, 24, 22, and 19 gage conductors. The smaller gages are usually employed close to the exchanges where the cables are larger and frequently in underground ducts.

Open wire toll lines are built of 25 foot, class 4, fully treated jack pine poles with spans of 165 feet. The top crossarm west of Rimouski carries four pairs of 128 mil copper, J5 transposed and has a capacity of 64 circuits. East of Rimouski, the toll line carries two phantom groups of copper wire, one group follows the north shore of the Gaspé Peninsula, whereas the other cuts across the peninsula from Mont-Joli to Matapedia and then along the Bay of Chaleur to Gaspé. Cable now is being added to these toll routes. For short distances, loaded cable pairs are used for trunks but cable carrier telephone systems or combined open-wire cable systems such as types *ON* or *45BN* are more economical for longer distances. A microwave radio relay system is planned to relieve the major toll route.

Broad band radio telephone systems, operating in the 72 mc to 108 mc and 900 mc bands provide communications across the St. Lawrence River. On such facilities, 72 carrier channels of type *45BX2* can be superimposed. Groups of 12 circuits can be dropped at intermediate points by using carrier hybrid bridging arrangements.

Communication facilities on open wire toll lines are provided largely by carrier systems such as types *C, O* and *45A*. These carrier systems are equipped with automatic regulators to compensate for changes in line attenuation. Five 18-channel systems of voice frequency carrier telegraph are operated over channels of carrier telephone equipment from Rimouski.

Québec-Téléphone now operates 39 dial exchanges. Equipment features, floor plans (layout), and buildings for offices of less than 1,700 telephone stations have been standardized to conserve engineering and installation time. The smaller buildings up to a capacity of 800 stations are fire resistant, larger offices are fireproof. By converting a number of manual exchanges to dial every year, Québec-Téléphone is following a definite program to improve service and derive more benefit from direct distance dialing.

Digest of paper 57–10, "Development in Communications in the Lower St. Lawrence Valley," recommended by the AIEE Committee on Wire Communications Systems and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21–25, 1957. Published in AIEE *Communication and Electronics*, vol. 76, March 1957. pp. 26-39.

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# Ground Power Equipment for Support of Air Force Weapons

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**An engineering study has been made for the Air Research and Development Command of the U. S. Air Force, the object being the preparation of recommendations for needed development in the area of ground support for secondary power. The results, as they pertain to ground electric power, are discussed.**

IN ORDER TO MAKE a prediction of the probable needs in ground power, it is first necessary to predict the trends of the airborne secondary power systems. In aviation terminology, secondary power is defined as that power which is used for purposes other than the propulsion of aircraft and missiles. These trends cannot be estimated without first making some assumptions, if not predictions, as to the trend of aircraft and missiles. This was the approach that was used during a recent engineering study made for the Air Research and Development Command of the U.S. Air Force. The study produced much information of indirect value which was to contribute to the planning of ground power. The results as they pertain to secondary power and the support thereof are presented here.

This article is limited to a discussion of ground electric power. It was found that weapons of the future can be served by five families of power units: (1) ramp unit, (2) trailer mounted mobile unit, (3) stationary or portable unit, (4) fixed base power unit, and (5) electric motors.

Of these, all but one are primarily sources of electric power. The second item will be most useful as a hydraulic power unit. It became apparent that the turbine prime mover will rapidly supplement and then supersede the reciprocating engine. Thus, it was concluded that future developments should be based on the turbine drive.

## GENERAL PREDICTIONS

ABOUT THE ONLY SAFE PREDICTION that can be made with regard to aviation development is that any given period will yield about twice the technological development which was accomplished during the same length of time in the immediate past. It is becoming increasingly apparent that there is no limit to the flight altitude and speed that will be achieved. The thermal barrier will be overcome by developments in materials, or by flight at higher altitudes. The developments in missiles will lead the way into outer space, but soon afterward, the missile will be converted to a manned aircraft of essentially similar performance.

Flight into outer space will advance the limits of environmental conditions. Higher flight speeds bring increased aerodynamic forces and the need for greater power in secondary power systems for the servo controls. Contributing to the achievement of higher speeds will be more compact designs of fuselage and wings. Yet more and more secondary powered equipment will be installed in the reduced space. Heat losses from that power must be carried away. As a result, the importance of air conditioning will be increased. Development of components that can operate in higher ambient temperatures will reduce the power required for air conditioning, but the need will probably continue.

The higher speeds of the future will bring new problems in precision. Navigation, whether by human skill or by missile robot, will need greater precision. The necessary accuracy starts in the secondary power system, particularly in the electric system. If more accuracy can be built into the input secondary power system, less will have to be added by electronic means. Heretofore, only the electric system has been the subject of the demand for greater precision, but it is likely that other types of secondary power will tend toward greater precision in the future.

The hydraulic system will be the next to feel the pressure toward better control. Hydraulic power is the ideal means for servo control, inasmuch as it provides ample power with light weight, is well suited to exerting lineal forces, is reasonably fast in response, and is not resilient or soft.

The transistor will reach a major plateau of its usefulness by 1962. It has not brought all the boon that was hoped. It will permit a great reduction in the size and power consumption of many electronic systems, particularly digital computers. This will reduce the amount of air conditioning that is needed to remove electrically generated heat, but it will demand more precise temperature control. Many transistors have given characteristics over only a small range of temperature. To achieve the ultimate precision in the electronic system, it will be necessary to control temperature around the transistors to quite narrow limits.

The power rating of the electric system will continue to grow despite the advent of the transistor, but its advance in size will not be as dramatic as in the last 10

Essentially full text of paper 57-500, recommended by the AIEE Committee on Air Transportation and approved by the AIEE Technical Operations Department for presentation at the AIEE East Central and Middle Eastern District Meeting and Air Transportation Conference, Dayton, Ohio, May 7-9, 1957. Scheduled for publication in AIEE *Applications and Industry*, 1957.

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years, nor will it keep pace with the growth in weight and speed of aircraft.

The hydraulic system will have a rapid growth in the next 10 years. Aircraft are now reaching speeds at which manual control is out of the question. Power boost must be used. Until now, it has been possible to use aerodynamic forces to counterbalance control forces, so that manual effort could control the flight. Power boost has been added to make the job easier. Now that aerodynamic forces are too large to use in this manner, and since power boost is always available, the aircraft designers may elect to design instability into the aircraft deliberately, in order to attain still higher performance. This will increase the power rating of the secondary power system, and will force installation of a dual system in many types of aircraft, in order to have a safety factor for emergencies. A tenfold growth of hydraulic-installed power in the next 10 years is predicted. Much of this results from the increased weight and speed of the aircraft, and some from increased uses for hydraulic power.

Low-pressure pneumatic power has been tried in the past 5 years and seems to be settling into a place of usefulness. It is tempting to use bleed air from the turbine engines through a pneumatic coupling to drive generators of secondary power. Although it is not an efficient coupling, it does remove accessories from the engine and permits a reduction in the frontal area of the engine. Advantage could also be taken of the ducts for deicing air as a path for pneumatic power. But, it is likely that deicing will be omitted on any aircraft that can cruise at altitudes beyond icing conditions. Today's piston engine aircraft which are not able to evade all icing conditions use deicing equipment for less than 3% of the total flight hours. Military aircraft need only pass through icing conditions en route to or from iceless environment and do not need deicing equipment at all.

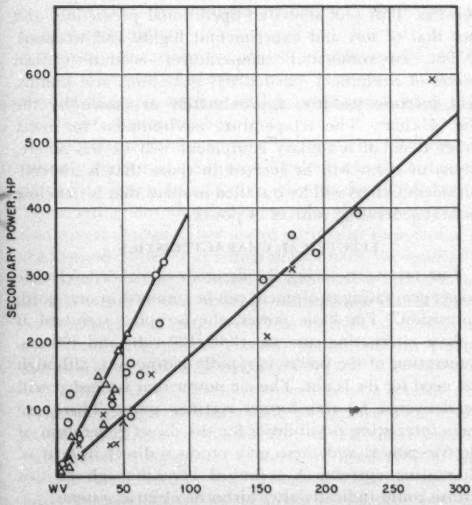


Fig. 1. Total secondary power load with respect to product of weapon gross weight and speed in Mach number.

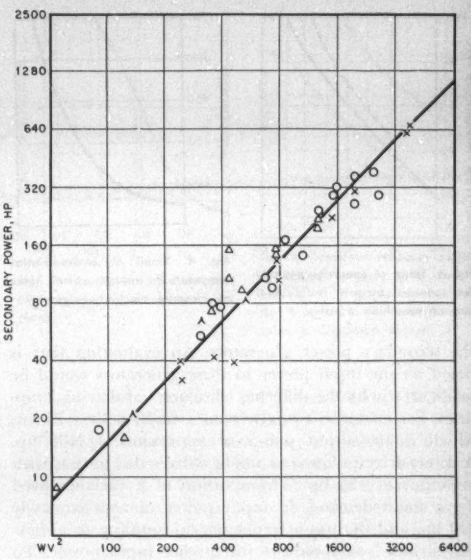


Fig. 2. Total secondary power load with respect to product of weapon gross weight and square of speed, using indicated air speed.

High-pressure pneumatic power can be used in many special one-shot jobs, and as stored energy in the smaller missiles. This is a very economical way in which to carry stored power. The maximum pressure in such storage is likely to exceed 10,000 psi in the next 10 years.

The airborne auxiliary power unit will have new importance in the future. Trends in weapon propulsion show that a static device may be the source of thrust in future designs, thereby removing the source of rotary power for electric generators. The rocket engine in missiles and experimental aircraft is a forerunner of this trend. The increased use of the ram-jet engine is another. Space travel will bring entirely new operational concepts. A separate and independent source of electric power is and will be needed in such aerial vehicles.

## DETAILED PREDICTIONS

It was found that the total of secondary power has a relationship to the weight and speed of the weapon. In military aircraft, there is a small amount of power, as for radio communications, that may be said to be common to all aircraft without regard to size. However, the amount of such power is almost negligible and is considered to be a part of the total for this estimate. The total power that is to be considered includes electric, hydraulic, pneumatic, and air conditioning.

It is necessary to consider only the power delivered by

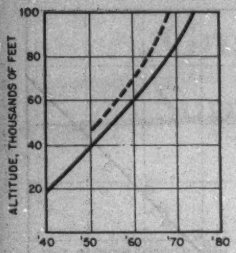


Fig. 3. Trend of operating altitude for manned aircraft (solid line) and air-breathing missiles.

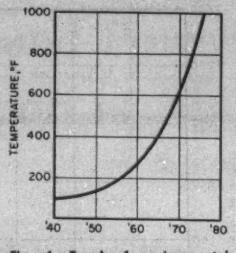


Fig. 4. Trend of environmental temperature around some items of airborne electric equipment.

the secondary power generators. An evaluation that is based on the input power to these generators would be made erratic by the differing efficiencies of driving couplings. For example, two alternators might deliver 75 kw, which is an output power of approximately 100 hp. A direct-driven alternator might deliver this output with an input of 125 hp. The addition of a variable-speed drive could demand an input power of approximately 140 hp, and the use of a pneumatic coupling to a driving turbine could require still higher input power. To avoid these several choices, only the output power of the secondary generators and pumps is considered.

The first attempt to make this analysis used secondary power as a function of the product of weapon weight and speed. The equation

$$P = kWV$$

where $k$ is a constant, was used. The results of a plot of many aircraft is shown by Fig. 1. The ordinate of this plot is the total secondary power in horsepower. The abscissa is the product of gross weight in thousands of pounds and of velocity in Mach numbers. Two paths of correlation appear. Most of the supersonic aircraft lie on the upper line. It is obvious that this approach is not satisfactory, and that secondary power is dependent on an exponent of the velocity factor.

To bring better correlation, three steps were taken. First, indicated air speed was used instead of Mach number. Second, the square of the velocity was used; finally, some allowance was made for differing practices among weapons manufacturers with regard to hydraulic servo control systems. When dual systems were installed, the power for only one of them was counted. These changes brought the two curves together as shown by Fig. 2. This correlation is a reasonably straight line that can be projected into the future with some degree of certainty. This prediction of total power is important in the planning of ground power units, because the power rating of the servicing power unit will have some relation to the installed secondary power. After studying the highest single loads of the systems combined with the air-conditioning requirements that would accompany testing of those loads, it was decided that the ground power electrical servicing unit would need to have about half the power rating shown for the total secondary system.

The air-conditioning loads of commercial transports cause their position on the plot to be high in the case of the older designs. As we move into the area of jet transports, the secondary power requirements come into line with those of military aircraft. This shows that the human factor becomes of less importance with higher performance insofar as air conditioning is concerned. In the future, the air-conditioning needs of the weapon itself will far overshadow those for the personnel in the weapon.

The operating altitudes of weapons directly concern the environment for which secondary airborne power equipment must be designed. These are of indirect interest in the ground power unit, for it will often be required to drive airborne generator units in the servicing of the weapon. A projection of the trend in operating altitude of weapons is shown by Fig. 3 where the solid line shows it for aircraft and the dotted line represents missiles. This plot shows an operational prediction, and not that of test and experimental flights and weapons.

The environmental temperatures around critical pieces of equipment, particularly generators and pumps, will increase steadily, approximately as shown by the Fig. 4 chart. The temperature environment for most other items of secondary equipment will be less severe. Many of them will be located in space that is air conditioned. Others will be installed in space that is not close to heat-generating sources of power.

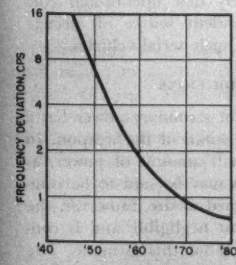


Fig. 5. Trend in reduction of frequency deviation (half of total tolerance).

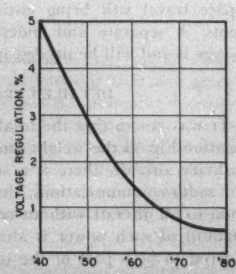


Fig. 6. Trend in reduction of voltage regulation (half of total tolerance).

## ELECTRICAL CHARACTERISTICS

THE PROBLEMS facing the designer of airborne electric power generating equipment can be summed in one word, "precision." For basic power, the accepted standard is 3-phase alternating current at 208/120 volts and 400 cps. Generation of d-c power is rapidly fading out, although the need for d-c is not. The d-c power that is needed will be delivered by transformer–rectifier units. There are some interesting possibilities for the direct generation of electric power, and these may produce direct instead of alternating current. A technical breakthrough of this nature could radically alter airborne electric systems.

Some consideration is being given to higher voltage systems that may be needed in larger aircraft of the

future. The industry has tentatively agreed on a 3-phase 440-volt system for the proposed applications. There are several applications for other and higher frequencies, and they are brought about by the need for faster response from magnetic amplifiers. These frequencies have included 800, 1200, 1600, 2000, 2400, and 4800 cps. If such special frequencies continue to be needed, it should not be a multiple of the basic power frequency, 400 cps. One frequency that should be avoided is 2400 cps, for that is the ripple frequency of a 3-phase transformer rectifier unit. Successful development of power transistors that can replace the function of magnetic amplifiers will reduce or eliminate the need for special frequencies.

The preciseness of frequency control was one of the great debates encountered during the survey. There are four schools of thought. The first believes there is limited application on turboprop engines for variable-frequency alternators to supply raw or basic power. The second calls for basic power in which the frequency is controlled in a total range of 20 cycles per second, 400 $\pm$ 10 cps. The third wants better control, and it is the prediction of this group that is shown by the plot of Fig. 5. The graph shows the permitted variation in each direction, half the total variation. All of these groups are fully aware of the need for very precise frequency control in critical electronic systems, but they believe that the refinement can and should be done in the power supply of the electronic equipment. The last group contends that it is just as easy to refine all of the power at the outset, rather than a part of it.

Where the drive for precision in frequency will end is not easy to predict. Temperature-controlled crystals can deliver a precision in the order of $10^{-8}$, which means a precision of $0.25 \times 10^{-6}$ cps. The demand of the precision school today is for 0.01 cps, but there is little reason to doubt that the ultimate in precise control will be wanted eventually.

Greater accuracy in the control of voltage will also be sought. The goal of weapons manufacturers is shown by the Fig. 6 graph. Such precision can be realized at only one point, the central bus.

Wave shape of the output voltage will be more accurately limited in the future. The trend in the reduction of any deviation from a sine wave is shown by Fig. 7. These reductions apply to harmonics, single or multiple, and to crest factor. They are of particular importance to the ground power unit which must match the quality of the airborne units. Modulation is an undetermined factor in this trend at this writing. Modulation can occur to both voltage and frequency. The variable-speed drive is a major source of modulation, particularly in voltage and to a lesser extent in frequency.

The modulation of frequency can cause a considerable pulse of voltage. Measurements by one weapons manufacturer with the co-operation of an electrical supplier have shown these pulses to be more than 10% of line voltage, far exceeding the permitted variation of regulated voltage. Again, these pulses of voltage have not been the designated cause of any difficulty in load equipment, but it is feared that if instrumentation is made

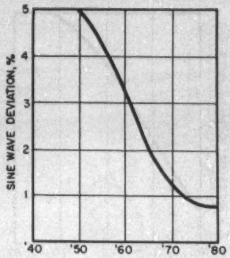


Fig. 7. Trend in the reduction of factors which affect the wave shape.

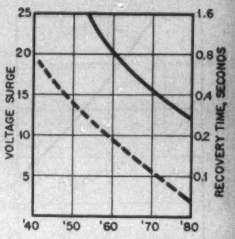


Fig. 8. Trend in reducing factors of voltage surges. Solid line is amount of surge in either direction and dotted line is time to recover to regulated values.

available that will detect the pulses, there will follow an effort to reduce or remove the pulses.

Recovery from surges caused by the addition or subtraction of unit load is also scheduled to tighten as shown by Fig. 8. A single surge of power in an airborne system is not particularly disturbing, but periodic surges can be very disturbing. A single surge will throw the pip of a radar scope off limits, but it soon recovers. Repetitive surges can be troublesome. In missile flight, the electrical loading can be scheduled to overcome this difficulty.

As more experience is gained with 3-phase electric systems, more of the individual loads go from single to 3-phase operation. The weapons manufacturers are very careful to balance single-phase loads by distribution among the three phases. With this progress comes a demand for less and less difference in phase voltages. The trend is shown in Fig. 9.

## OTHER SECONDARY POWER

THE COMPARABLE TRENDS in hydraulic systems will be of interest to the electrical engineer, particularly one who is concerned with ground power. The trend in system pressure is shown by Fig. 10. The greater power demands that are coming in the next 10 years would justify a still higher growth in pressure, but the zone of diminishing returns is reached at about 5,000 psi and even less in smaller aircraft. Beyond this critical value, the weight of heavier tubing offsets potential gains.

The trend in fluid temperature within the hydraulic system is shown by Fig. 11. The growth in temperature is due to two factors: the demand for more power and the proximity to sources of great heat. Silicone fluids will permit a rise to about 800 F from the current values of 275 F. To achieve the maximum limits that are forecast, it is likely that lessons will be drawn from nuclear experience to use liquid metals as the fluid. Hydraulic fluids face another hazard of the nuclear era. Neutron radiation will damage many of the hydraulic fluids that are known today.

There will be an increasing demand for more accurate control of system pressure. The possible trend is shown by Fig. 12. This requirement is not as severe as that which has been imposed on the electric system. At the

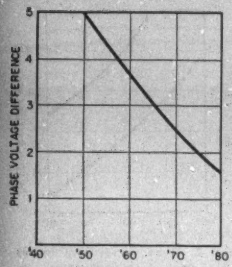


Fig. 9. Trend in reduction of differences between phase voltage of 3-phase system.

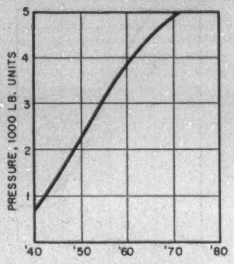


Fig. 10. Trend in the pressure of airborne hydraulic system.

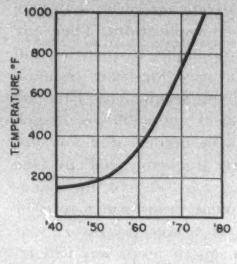


Fig. 11. Trend in hydraulic fluid temperature for normal operation.

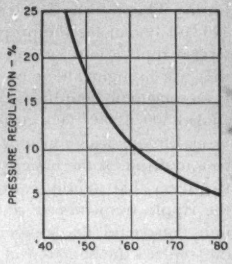


Fig. 12. Trend in pressure regulation (total tolerance).

same time that the regulation is reduced, it is likely that suppression or reduction of ripple will be required. As pump operating speed grows from the current rating of approximately 4,000 rpm toward 12,000 rpm in the next 10 years, the amount of ripple will probably decrease.

Pneumatic power will follow the same trends as hydraulic with regard to pressure and ripple in high-pressure airborne systems. The pressure in stored systems is likely to more than double those for operating systems in the same period. Pressures as high as 12,000 psi can be expected for use in missiles during the next 10 years. This can be important to the ground power units which will service such missiles, and will be used to recharge the storage bottles.

## FAMILIES OF GROUND POWER UNITS

THE FOREGOING DISCUSSION lists some of the factors that are concerned in the planning of ground power. After appraising the many major needs for power within the Air Force operations, it appears that they can be met with five families of power units, each of which will need two or more ratings within the family. These are

1. A self-propelled ramp vehicle to supply electric (and other) power for servicing and maintaining aircraft or missiles. This vehicle can take two forms; the first a conventional vehicle which can be transported in cargo aircraft, and the second, a "pod" mounted on but separable from the tactical aircraft that it supports.

2. A trailer mounted unit for nonperiodic use. These will be single purpose units as for hydraulic power or air conditioning.

3. Portable (skid mounted, stationary) electric generating sets of higher power rating than that of the mobile vehicle.

4. Electric motor drives.

5. Fixed power plants, electric, of rather large ratings to service detection and missile control centers.

The first family has been of greatest interest to the Air Force and to weapons manufacturers. The concept of a ramp vehicle has grown steadily in recent years, and several designs have appeared. Today we are faced with the need for still more power from such a power unit, and we have a chance to do some planning around a turbine prime mover within that vehicle. The turbine is ideally suited to driving an alternator at constant speed, as it is essentially a constant-speed device itself. Since a turbine is used, it gives a capability of delivering low-pressure pneumatic power in considerable amounts, and this bleed air can be used for other purposes.

When electric power is delivered and used within a weapon, the excess heat must be withdrawn by means of cooling air. This means that the power unit must have an air conditioner to generate that cooling air. The air conditioner can use air cycle techniques, inasmuch as compressed air already is available from the turbine compressor section, or it can use a shaft-driven compressor.

Self-propulsion will be provided by an air coupling to a separate turbine unit. Four-wheel drive is desirable, because the unit can serve as a tow vehicle also. The overall weight of a combined unit of approximately 250-hp rating need not exceed 4,000 pounds. If higher dead weight is needed to improve towing capability, ballast can be added.

A possible layout of a suitable vehicle is shown by Fig. 13. It will be noted that a surprisingly low silhouette can be maintained. The vehicle as sketched is 15 feet long, 6 feet wide, and little more than 4 feet high. The secondary power section of the vehicle has been located at the rear of the unit, to make it easier to meet the needs of the weapons-system concept. This concept, as practiced by the U. S. Air Force and the aviation industry, has accelerated the development of advanced weapons. It is very jealously guarded by both the military and the industry, and yet both agree that a reasonable amount of standardization is to be desired. For that reason, those elements of the ground power unit that are concerned with matching the secondary power system of a weapon exactly are kept to the rear of the unit. The four wheels, propulsive means, air conditioner, and turbine drive are not concerned with any particular weapon, and are portions of the vehicle that can be standardized. The secondary power alternator (and generator, if used) are directly involved in the matching of airborne character-

istics, and they are located to the rear of the vehicle where they can be readily interchanged. Some designs of alternators do not use AN standard mounting flanges, and it is proposed that the reduction gear box which receives power from the turbine and drives the alternator, also be readily removable. Now, by changing a module at the rear of the vehicle to another similar unit that matches the airborne equipment, an exact matching of the airborne system can be made. Associated equipment and controls should also be removable through the modular concept of design.

In the sketch of Fig. 13, space 1 has been allocated for the turbine prime mover. Inlet and exhaust are on the upper surface of the vehicle. Space 2 is for the reduction gear box and driven devices, alternators, generators, pumps and air conditioning compressor, as needed. Space 3 is for the control of the secondary power system. Space 4 represents ballast tanks which can carry a variety of fluids. Fuel for the turbine is an obvious need. If ballast is needed, other tanks can be filled with water. A tank can be reserved for hydraulic fluid reservoir if the weapon needs it. If the weapon has a ram-jet engine, one or two tanks can be used as a storage for the simulated fuel that is needed for ground tests of the engine. The air-conditioner unit is located at space 5.

In the second family of power units, the first type that is likely to reach power values which justify a turbine drive is the hydraulic power unit. Within 10 years, a unit to deliver 50 gallons per minute at 5,000 psi will be needed. This will require a 200-hp prime mover. It should be designed with the module concept also, because it is apparent that in the rapid development of hydraulic systems, many pumps and fluids will emerge. One weapon may have systems of differing pressure ratings, and systems that use different fluids. After 10 years, there may be a need for external cooling during the ground checking of hydraulic systems, and this will require an air conditioner unit as well.

A suggested form for the stationary power unit of the third family is shown by Fig. 14. Again, the turbine is selected as the prime mover. This type of unit may be the successor to the familiar diesel-engine-driven alternator. As shown, the unit is driving a 400-cps alternator. This is to be recommended for all Air Force power around weapons and their associated controls. In this type of unit, fuel economy is to be sought, inasmuch as it will be called on to operate continuously. It is suggested that the unit be able to operate without shutdown for 9,000 hours, or one year, to meet Air Force needs in its remote stations.

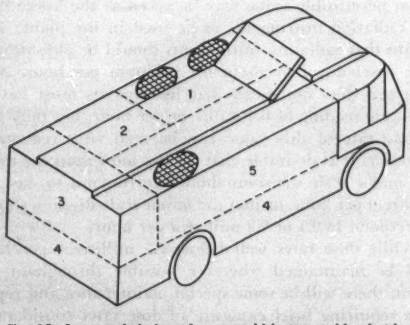


Fig. 13. Suggested design of ramp vehicle to provide electric power to weapons. (1) Turbine prime mover; (2) Gear box and driven units, such as alternator, generator, and pumps; (3) Control space; (4) Tanks for various fluids and ballast; (5) Air-conditioning unit.

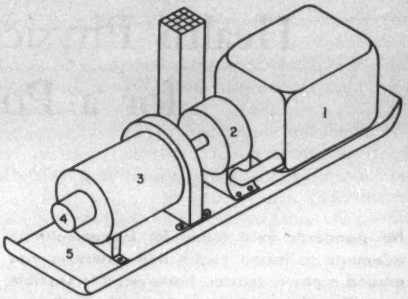


Fig. 14. Suggested arrangement of stationary electric generating set. (1) Turbine drive; (2) Free piston compressor; (3) Alternator and gear reduction; (4) Exciter; (5) Mounting base.

A free piston compressor appears to be a promising source of the hot gases to drive this turbine. It can use a great variety of fuels, and with diesel oil, it is able to exceed the performance of the diesel engine in regard to fuel economy. A very conservative design of a 500-kw unit to deliver power at 400 cps should not weigh more than 3,000 pounds. The combination should offer good fuel economy, long life between shutdowns and overhaul, and weight low enough to make transportation by air very easy. Among the disadvantages, this compressor is still a reciprocating device, although it is simpler than its diesel engine counterpart. It also needs cooling, usually liquid, which adds to its complexity. Filtering of the inlet air will be just as important as for the reciprocating engine it supplants.

In line with the thought that the stationary power unit deliver 400-cps power, it is also suggested that the last family to be considered here, the electric motor drives, also be designed to use 400-cps power. They can use higher speeds and this, with the higher frequency, will give great reductions in unit weight. The higher speeds are more suitable to the driving of many of the pump units that are forthcoming.

The fixed power plants for missile detection and control centers, are too large a subject to be a part of this paper. They too will present some notable problems in quality of power, reliability, life, and security. Ground power for the support of weapon systems has grown in 20 years from a unit comparable to a power lawn mower to a fixed power plant capable of supplying the needs of a small city.

# Health Physics Instrumentation for a Power Reactor

G. H. WHIPPLE

**No standards exist today for instrumentation adequate to insure health and safety in and around a power reactor. However, it is possible to outline the measurements required, the required ranges and accuracies, and classes of instruments and their application. Based on these outlines, instrumentation for a representative power reactor is suggested.**

THE TIME WILL COME, probably within 5 to 10 years, when the instruments installed in a reactor power plant for the protection of workers and the public will be standardized and will demand no more attention and thought than are now given to pressure and temperature instruments in conventional power plants. Today, however, there is little power-reactor operating experience, and radiation hazards and their control and measurement are matters of some debate. The state is characteristic of a young art, and will certainly pass as experience accumulates.

This article examines, in general terms, the fundamental requirements of the instruments needed to evaluate and control radiation hazards in a power reactor plant and attempts to indicate the direction that the development of this instrumentation probably will take.

## THE MEASUREMENTS REQUIRED

IT IS PROPER TO BEGIN by considering the measurements necessary to insure the health and safety of people, both inside and outside the plant. These measurements fall into two broad categories: (a) those concerned with external exposure to radiation; and (b) those concerned with exposure from radioactive materials which enter the body, that is, with internal exposure.

Radiations presenting a possible hazard from internal exposure are beta ($\beta$), gamma ($\gamma$), and neutron. Alpha ($\alpha$) particles present no external hazard because their range in tissue is so short that they are unable to penetrate the nonliving outer layer of the skin. For the same reason, $\beta$ particles with energies less than 0.07 million electron volts (mev) present no external hazard.

Radiations presenting a possible hazard from internal exposure are $\alpha$, $\beta$, and $\gamma$. Radioactive materials can gain access to the body by ingestion, inhalation, incision, and in a few special circumstances, by absorption through intact skin. Radioactive material must be free to move about in order to get into the body in any of these ways. Thus, instrumentation for the control and prevention of internal exposure will measure contamination on surfaces, in air, and in water.

Once radioactive material has entered the body, it is possible to estimate the amount retained by measuring (a) the amount excreted in the urine or feces, (b) in a few cases, the radon and thoron concentrations in the breath, and (c) recently, the $\gamma$ or X radiation emitted by the material inside the body with large whole-body counters[1,2] or other special devices.

## SENSITIVITY RANGES REQUIRED

CONSIDERATION of the required ranges of sensitivity for protection measurements starts with the maximum permissible dose rates and concentrations recommended by the National Committee on Radiation Protection[3] and now beginning to appear in various State and Federal regulations.[4-7] The basic figure throughout these recommendations and regulations is 0.3 rem* per week.

The normal work week is 40 hours. If the weekly dose of 0.3 rem is not be exceeded, the maximum permissible dose rate for continuous exposure is 7.5 millirems per hour. It is obviously desirable to maintain dose rates well below 7.5 millirems per hour wherever possible. Many atomic energy installations operate on the principle that dose rates shall not exceed 1/10 of this value without specific justification. Thus, it is desirable to be able to measure radiation dose rates somewhat lower than 1/10 the maximum permissible 40-hour rate.

Somewhat arbitrarily, a dose rate at 5% of the maximum permissible value may be taken as the lower limit for radiation instruments to be used in the plant. This means that radiation instruments should be able to indicate doses down to about 0.4 millirem per hour. Note that this does not mean that instruments must have a full-scale reading of 0.4 millirem per hour, but only that a dose rate of this value can be read with reasonable accuracy. It is desirable that on the most sensitive range the major scale divisions should correspond to, say, 0.5 millirem per hour, or that the minor scale division should correspond to 0.1 or 0.2 millirem per hour.

While dose rates well below 7.5 millirems per hour will be maintained wherever possible throughout the plant, there will be some special maintenance and repair jobs requiring brief exposure to dose rates considerably

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* The abbreviation "rem" stands for "roentgen equivalent man," and is that dose of any ionizing radiation that produces a biological effect equal to that produced by 1 roentgen of high energy X rays. For X and $\gamma$ rays, 1 r = 1 rem. For other radiations, the roentgen does not apply, and the rem is that dose biologically equivalent to the roentgen.

higher than this. Even while insisting that such work be kept to an irreducible minimum, one must set some upper limit to the dose rate that may be received.

The shortest period in which useful work can be done and regulated with accuracy is about 30 seconds. In the limit, it may be necessary to permit a man to receive his entire weekly exposure in the course of such special work. This means that work in radiation fields as high as 40 rems per hour can be permitted under strictly regulated conditions. It is pertinent to point out that instruments with the radiation-sensitive element on a long pole enable the surveyor to measure such intense fields without having to expose himself to these fields.

Thus, for radiation instruments to be used in the plant, it is desirable to have ranges from about 0.4 to 40,000 millirems per hour. It is not, of course, necessary that every instrument have this range of 100,000 to 1, but it will be necessary to have instruments that among themselves can cover this range.

The discussion to this point has been concerned entirely with the measurement of external radiation. A similar, but somewhat less precise, line of reasoning indicates the need for corresponding limits for the measurements of air- and water-borne contamination, starting in both cases with the maximum permissible concentrations recommended by the National Committee on Radiation Protection.[3] In the few cases where levels higher than these upper limits may occur (e.g., the reactor core gas system, and the fuel element decontamination drain), the monitors will not be required to approach within several orders of magnitude of the lower limit.

The usual maximum permissible levels stipulated for the public outside an atomic energy plant are 1/10 of the occupational levels.[3-7] Furthermore, it appears from recent studies of possible effects of radiation exposure on the whole population that even lower limits may be specified.[8,9] Instruments for environmental monitoring must, therefore, be capable of reading dose rates and concentrations down to about 1% of the levels recommended as maximum for occupational exposure, that is to say, down to a dose rate of about 0.08 millirem per hour for external radiation.

The upper limit for environmental instruments is not an easy value to establish. One certainly expects that levels as high as 10 times the maximum permissible occupational levels will not be attained even under the most unfavorable combination of circumstances. On the other hand, one will always be plagued by doubts about any upper limit for these instruments. If everything should go wrong at once, it would be indefensible to be in the position of finding all the environmental instruments blanked out by going off scale at 10 times the occupational, or any other, level. Fortunately, many of the devices used for environmental monitoring have no upper limit to the concentrations they can indicate on reanalysis. An upper limit of 10 times the maximum permissible occupational level is taken here, but it may be well either to extend this limit, or to make some provision for higher range measurements in case the need for them should arise.

Table I summarizes the conclusions reached concerning the limits of range for radiation instruments, both for in-plant measurements and for environmental measurements. The column headed "Units" gives the units of dose rate, flux density, or concentration in which the radiation or contaminant is commonly measured and expressed. The first column of figures gives the maximum permissible levels for occupational exposure. The next two columns give lower and upper limits for in-plant instrumentation, and the last two columns give the corresponding limits for environmental instrumentation.

The contamination levels given in Table I are for gross $\alpha$ and gross $\beta$, $\gamma$ activity. These are the levels that must be used unless the isotope actually contributing the activity is known. In situations where the actual

**Table I. Required Instrument Ranges**

| Radiation | Units | MPE Rate,[1] or MPC[2] for 40-hr Week | In-Plants Limits | | Environmental Limits | |
|---|---|---|---|---|---|---|
| | | | Lower | Upper | Lower | Upper |
| Any radiation | m rem/hr | 7.5 | 0.4 | $40 \times 10^3$ | 0.08 | 80 |
| $\gamma$ | mr/hr | 7.5 | 0.4 | $40 \times 10^3$ | 0.08 | 80 |
| $\beta$ | m rad/hr | 7.5 | 0.4 | $40 \times 10^3$ | 0.08 | 80 |
| Slow neutron | n/sec. • cm$^2$ | 2,000 | 100 | $10 \times 10^6$ | 20 | 20,000 |
| Intermediate neutron | n/sec. • cm$^2$ | 1,000 | 50 | $5 \times 10^6$ | 10 | 10,000 |
| Fast neutron | n/sec. • cm$^2$ | 50 | 2.5 | $0.25 \times 10^6$ | 0.5 | 500 |
| **Air Contaminant** | | | | | | |
| Gross, particulate $\alpha$ activity[3] | $\mu$c/cc | $6 \times 10^{-12}$ | $3 \times 10^{-12}$ | $3 \times 10^{-8}$ | $6 \times 10^{-14}$ | $6 \times 10^{-11}$ |
| Gross, particulate $\beta, \gamma$ activity[4] | $\mu$c/cc | $6 \times 10^{-10}$ | $3 \times 10^{-11}$ | $3 \times 10^{-6}$ | $6 \times 10^{-12}$ | $6 \times 10^{-9}$ |
| Gross, gaseous $\beta, \gamma$ activity[5] | $\mu$c/cc | $1.5 \times 10^{-6}$ | $8 \times 10^{-8}$ | $8 \times 10^{-2}$ | $1.5 \times 10^{-8}$ | $1.5 \times 10^{-5}$ |
| **Water Contaminant** | | | | | | |
| Gross $\alpha$ activity[3] | $\mu$c/cc | $4.5 \times 10^{-6}$ | $2 \times 10^{-7}$ | $2 \times 10^{-2}$ | $4.5 \times 10^{-8}$ | $4.5 \times 10^{-5}$ |
| Gross $\beta, \gamma$ activity[4] | $\mu$c/cc | $2.4 \times 10^{-6}$ | $1 \times 10^{-7}$ | $1 \times 10^{-2}$ | $2.4 \times 10^{-8}$ | $2.4 \times 10^{-5}$ |

1. Maximum permissible exposure rate for a 40-hour week; National Bureau of Standards Handbooks 55 and 59
2. Maximum permissible concentration for a 40-hour week; National Bureau of Standards Handbook 52. 1 $\mu$c/cc = $2.22 \times 10^9$ disintegrations/minute/liter
3. Concentrations set by plutonium-239
4. Concentrations set by strontium-90
5. Concentrations set by argon-41; if iodine-131 may be present, these figures must be multiplied by 0.01

**Table II. Classes of Health Physics Instruments and Their Applications**

| | Instrument Class | | | | |
|---|---|---|---|---|---|
| | Portable | Mobile | Fixed, Continuous Monitors | Personal Monitors | Laboratory Devices |
| External Radiation | $\beta,\gamma$ neutron | $\beta,\gamma$ neutron | $\beta,\gamma$ neutron | $\beta,\gamma$ neutron | — |
| Surface Contamination | $\alpha,\beta,\gamma$ | $\alpha,\beta,\gamma$ | For personnel and laundry: $\alpha,\beta,\gamma$ | Nose swabs* Urine samples* | Smear samples: $\alpha,\beta,\gamma$ |
| Air-Borne Contamination | | | | | |
| In-Plant | — | Particulate $\alpha$ | Particulate $\beta,\gamma$ | Nose swabs* | Filters, grab gas |
| Air | | Particulate $\beta,\gamma$ Gaseous activity | Gaseous activity | Urine samples* | samples, $\alpha,\beta,\gamma$ |
| Effluent gas lines | — | Particulate $\alpha$ Particulate $\beta,\gamma$ Gaseous activity | Particulate $\alpha$ Particulate $\beta,\gamma$ Gaseous activity | — | Filters, grab gas samples, $\alpha,\beta,\gamma$ |
| Environmental air | — | Particulate $\alpha$ Particulate $\beta,\gamma$ Gaseous activity | Particulate $\alpha$ Particulate $\beta,\gamma$ Gaseous activity | — | Filters and fallout samples: $\alpha,\beta,\gamma$ |
| Water-Borne Contamination | | | | | |
| Effluent water lines | — | — | $\beta,\gamma$ | — | Spot samples, $\alpha,\beta,\gamma$ |
| Environmental water | — | $\beta,\gamma$ | $\beta,\gamma$ | — | Spot samples, plant and animal samples: $\alpha,\beta,\gamma$ |

*Counted by laboratory devices

isotope is known, the permissible concentrations will generally be higher than the tabulated values, since the concentrations in Table I are those for the most toxic constituents associated with power reactor operation.

## THE ACCURACY REQUIRED

ENGINEERS have a high respect for numbers. This respect, when carried over to dealings with less reverent folk, such as fishermen and real estate agents, can lead engineers into mistaken interpretations. Such has been the case when, on occasion, engineers have been turned loose with biological data, such as maximum permissible levels. Engineers sometimes find it hard to understand, or even believe that authorities in the field can propose values for these levels different by a factor of two or more.

Here it is possible to say only that very few "tolerance" values can claim an accuracy better than perhaps 20%. There are a number of reasons for this; perhaps the most important is the variation among individuals of any biological species. In some respects, the human species is the most variable of all.

Thus, on biological grounds, an accuracy of better than 10% can hardly be justified for protection instruments. On the other hand, an accuracy much poorer than 10% makes the determination of changes in instrument characteristics, and the maintenance and calibration more difficult than they are at a 10% level of accuracy. For these pragmatic reasons, it is desirable to have instruments with 10% accuracy at all readings, except perhaps at the lower limits given in Table I, where an accuracy of about 20% is acceptable.

Another way to consider the matter of instrument accuracy is to examine the types of decisions that will be based on the measurements. Most health physics measurements fall into one of four categories: (a) personal exposure data; (b) allowable working time, or required shield thickness; (c) changes in level with time, i.e., trends; (d) go, no-go decisions.

The first two categories involve numbers in the ranges given in Table I with the accuracy of 10% justified previously. Readings of the third type are intended to show whether some particular level of radiation is increasing or decreasing, and there is little to be gained from high absolute accuracy. It is usually sufficient here to know that the levels are of no biological significance and that the device is stable against instrument drift. An ionization chamber can indicate gradual or sudden buildup of activity on a filter without having a scale meticulously calibrated in milliroentgens (mr) per hour.

The fourth category, the go, no-go measurements, are made to find out whether prevailing levels are above or below some significant value, Such measurements are those made to determine whether respiratory protection is required, to locate beams of radiation and sources of contamination, to warn that entry into a particular area is unsafe, and to give notice when unusual or dangerous conditions arise. The only absolute number of importance here is that which divides the acceptable from the unacceptable. As long as the decision value is mantained accurately, quantitative readings above or below this value are usually of little importance.

The survey meter used to locate contamination is a good example of the go, no-go type of measurement. Such a device gives an audible "pop" in earphones for each ionizing event that occurs in the sensitive probe. The operator listens for any increase in the popping rate as he moves the probe over the surface he is inspecting for contamination. The ear is a sensitive rate device and with a little practice it is possible to detect very small increases in the rate of the pops. There is no instrument time constant to slow up the work and the eyes are free to observe the position of the probe. When contamination is found, the usual practice is to set about cleaning it up, rather than to make an accurate measurement of the disintegration rate. For this purpose, the addition of a counting-rate meter to the instrument contributes little but weight.

## INSTRUMENTS AND THEIR APPLICATION

HEALTH PHYSICS INSTRUMENTS fall into five general classes: (a) portable survey instruments, (b) mobile instruments, (c) fixed monitors, (d) personal monitors, and (e) laboratory devices.

Portable survey instruments are battery-operated hand-carried devices. Sensitive fast-acting instruments giving an audible signal are used to detect and locate sources of radiation and contamination. Some will give a quantitative indication of dose rate or disintegration rate in order that safe working times, shield requirements, and the progress of decontamination may be determined. The two functions of detection and measurement are frequently combined by equipping instruments with both earphones and a counting-rate meter.

Mobile instruments are line-operated devices, usually mounted on wheels, for use where a power cord is not a serious handicap, for instruments too heavy to be hand carried, and for instruments where power consumption or the requirement of continuous operation preclude battery operation. Such devices typically need less servicing than do battery-operated instruments.

Fixed monitors are line-operated devices with the radiation-sensitive element, or the collecting head, permanently mounted in a location of interest. The associated electronic equipment may be placed near the sensing element, but usually is placed some distance away. These devices typically operate continuously and drive one or more recorders and sometimes alarms as well. They are the watchdogs that give warning when a predetermined level is exceeded. Personal monitors are lightweight devices worn on the person to obtain an estimate of the individual's total exposure. Two types are in general use: film badges and pocket ionization chambers. Two other types appear likely to come into use for special types of personal monitoring: glass dosimeters for monitoring over long periods of time, particularly against large accidental exposures to $\gamma$ radiation; and neutron activation badges for large accidental exposures to neutrons.

There are two other forms of personal monitoring that should be mentioned here, although the instrumentation falls into the category of laboratory devices. These are nose swipes and urine analyses. Nose swipes use the human nose as a qualitative dust sampler and give a useful indication of an individual's exposure to air containing appreciable quantities of particulate radioactivity. Urine analysis is the method for obtaining an estimate of the amount of radioactive material that a person has absorbed in his body.

Laboratory devices are the precision $\alpha$ and $\beta,\gamma$ counters and the associated scalers, counting-rate meters, recorders, and sample changers used to determine the amount and physical characteristics of the activity in spot samples of water, soil, and air, in surface smear samples, in nose swipes, and in urine. A single-channel pulse-height analyzer for the analysis of $\alpha$ and $\gamma$ spectra is a useful device, and a densitometer and a microscope for reading film badges may be necessary. Included in this category also are the devices needed for special problems lying outside of the capabilities of conventional instruments.

Table II summarizes the various classes of instruments discussed here and their applications.

## INSTRUMENT MAINTENANCE

HEALTH PHYSICS INSTRUMENTS will present some new problems to the power plant instrument shop, and it is worth mentioning these to indicate how they may affect conventional shop practice.

The first problem is that of contamination. Any device that comes to the shop from the reactor side of the plant and, in particular, all radiation instruments must be checked for contamination and, if necessary, decontaminated before they are brought into the shop for service. Located by the receiving door of the instrument shop

**Table III. Radiation Transducers**

| | Gas Ionization | | | | |
|---|---|---|---|---|---|
| Radiation | No Gas Amplification | Proportional Counter | GM Counter | Scintillation Counter | Photographic Emulsion |
| Alpha particles | Very thin window;[1] air-filled | Very thin window;[1] usually air-filled | — | Very thin window;[1] zinc sulphide phosphor | NTA films for special problems[2] |
| Beta particles | Thin window;[3] air or gas | Windowless, gas-flow for Lab. counting | Thin window;[3] gas-filled | Thin window[3] | "Open window" portion of film badge |
| Gamma | Air, or gas at atmospheric pressure or above; thick wall[4] | — | Usually qualitative only; thick wall[4] | Can be made air- or tissue-equivalent; thick wall[4] | Shielded portion of film badge |
| Slow neutrons | $BF_3$ gas, or boron lining | $BF_3$ gas | — | Boron-loaded phosphor | NTA with, or without B or Li |
| Intermediate neutrons | Any slow neutron device surrounded by a moderator and shielded by cadmium; qualitative only | | | | |
| Fast neutrons | — | Recoil protons from hydrogenous filling and/or lining | — | Recoil protons from hydrogenous phosphor and/or radiator | Recoil protons in NTA films for neutron badge |
| | Any slow neutron device surrounded by a moderator and shielded by cadmium; qualitative only | | | | |

1. 1 mg/cm², or less
2. For example, for plutonium urinalysis
3. Greater than 4 mg/cm² (to stop $\alpha$ particles); preferably 7 mg/cm²
4. Greater than 0.5 gm/cm² (to stop $\beta$ particles)

**Table IV. Health Physics Instrumentation for a Representative Power Reactor**

| | Turbine Room | Control Room | "Cold" Labs. and Shops[1] | Plant Locker Room | Change Room | Laundry | Equipment Decon. Area | "Hot" Labs., Caves, and Shops | Fan, Filter and Stack | Active Gas Facility | Active Coolant Facility | Spent Fuel Facility | Reactor Building | Health Physics Lab. | Environmental Monitors | Spares | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. PORTABLE INSTRUMENTS** | | | | | | | | | | | | | | | | | |
| GM counter: $\beta,\gamma$ | — | — | — | — | .5 | — | .5 | .2 | — | .5 | .5 | 1 | 1 | 1 | 2 | 2 | 11 |
| Proportional counter: $\alpha$[2] | — | — | — | — | .5 | — | .5 | .2 | — | .5 | .5 | 1 | 1 | 1 | 2 | 2 | 11 |
| Proportional counter: neutron[3] | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | 1 | 1 | 3 |
| Ionization chamber: $\beta,\gamma$ | — | .5 | — | — | — | — | 1 | .2 | .5 | .5 | .5 | 1 | 1 | 1 | 1 | 2 | 11 |
| Ionization chamber: $\alpha,\beta,\gamma$ | 1 | — | 1 | — | — | — | — | 1 | — | .5 | .5 | — | 1 | — | 1 | 1 | 7 |
| **B. MOBILE INSTRUMENTS** | | | | | | | | | | | | | | | | | |
| Ionization chamber: $\beta,\gamma$ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 1 | 3 |
| Proportional counter ($BF_3$): neutron[3] | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 1 | 2 |
| Proportional counter (recoil proton): fast neutron | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | 1 | 2 |
| Proportional counter probe: $\alpha$ contamination[2] | — | — | 2 | — | 1 | 1 | — | 1 | — | — | — | — | — | — | — | 2 | 7 |
| GM counter probe $\beta,\gamma$ contamination | — | — | 2 | — | 3 | 2 | 1 | 2 | — | — | — | 1 | — | — | — | 2 | 15 |
| Air sampler, spot: $\alpha,\beta,\gamma$ particulates[4] | — | — | — | — | .2 | — | .2 | .5 | .2 | .2 | .2 | .3 | .2 | — | 3 | 2 | 7 |
| Air sampler, spot: $\beta,\gamma$ gases[5] | .2 | .1 | .1 | — | .1 | — | .2 | .2 | .3 | — | .3 | .5 | .2 | — | 1 | 1 | 4 |
| Air sampler, continuous: $\beta,\gamma$ particulates | — | — | — | — | — | — | .3 | .2 | .1 | .2 | — | .2 | — | — | — | 1 | 2 |
| Air sampler, continuous: $\alpha,\beta,\gamma$ particulates | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 1 | 3 |
| Air sampler, continuous: $\beta,\gamma$ gases[6] | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 2 | 1 | 3 |
| Water sampler, spot: $\alpha,\beta,\gamma$[4] | — | — | .3 | — | — | .3 | — | .5 | .3 | — | — | .6 | — | — | 24 | 2 | 28 |
| **C. FIXED MONITORS** | | | | | | | | | | | | | | | | | |
| Ion chamber, continuous: $\beta,\gamma$ | 3[6] | 1[6] | — | — | 1 | 1 | 1 | 5 | 3[6] | 4[6] | 7[6] | 2 | 4[6] | — | 10 | 3 | 45 |
| Proportional counter ($BF_3$), continuous: neutron[3] | — | — | — | — | — | — | — | — | — | — | — | — | 3[6] | — | — | 1 | 4 |
| GM hand and foot counter: $\beta,\gamma$ contamination | — | — | — | 2 | 2 | — | — | — | — | — | — | 1 | — | — | — | 1 | 6 |
| Air sampler, spot: $\alpha,\beta,\gamma$ particulates | 1 | 1 | 2 | — | 1 | 1 | 1 | 2 | 2 | 1 | — | 4 | 4 | — | — | 2 | 22 |
| Air sampler, continuous: $\beta,\gamma$ particulates | — | 1[6] | — | — | 1 | 1 | 1 | 3 | — | 1[6] | 1[6] | 3 | 2[6] | — | — | 2 | 16 |
| Air sampler, continuous: $\alpha,\beta,\gamma$ particulates | — | — | — | — | — | — | — | — | 1[6] | — | — | — | — | — | 8 | 1 | 10 |
| Air sampler, continuous: $\beta,\gamma$ gases[6] | — | — | — | — | — | — | — | — | 1[6] | 1[6] | — | 1 | 2[6] | — | 8 | 1 | 14 |
| Water sampler, continuous: $\beta,\gamma$ | 1[6] | — | — | — | — | — | 1 | — | — | — | — | — | — | — | 10 | 3 | 15 |
| $\gamma$ spectrometer, single channel | — | — | — | — | — | — | — | — | — | 1[6] | — | 1[6] | — | 1 | — | 1 | 4 |
| **D. PERSONAL MONITORS** | | | | | | | | | | | | | | | | | |
| Film badge: $\beta,\gamma$ | Everyone who enters the plant, including visitors, will be issued a $\beta,\gamma$ film badge. | | | | | | | | | | | | | | | | |
| Film badge: neutron | In view of the high cost of neutron film badges, their use will probably be restricted to those who enter the reactor building, including visitors. | | | | | | | | | | | | | | | | |
| Pocket ionization chamber: $\gamma$ | Direct reading pocket chambers (dosimeters) are probably the most useful device for special work in high radiation areas. Either the direct or indirect reading chambers will probably be issued to everyone who enters any area where radiation may be present. | | | | | | | | | | | | | | | | |
| Pocket ionization chamber: slow neutron | Direct reading chambers lined with boron will probably be issued to those who enter the reactor building. | | | | | | | | | | | | | | | | |

**E. LABORATORY DEVICES**

This equipment will be used in the health physics laboratory for physical analysis of the various spot samples collected in and around the plant.

| | *In Use* | *Spares* | *Totals* |
|---|---|---|---|
| Proportional counter: $\alpha$[2] | 6 | 2 | 8 |
| GM, or proportional counter: $\beta,\gamma$[2] | 6 | 2 | 8 |
| Scaler | 10 | 2 | 12 |
| Automatic sample changer | 4 | 1 | 5 |
| Densitometer[7] | 1 | — | 1 |
| Microscope (for nuclear track counting)[7] | 1 | — | 1 |

1. Includes instrument shop and offices
2. Proportional counter may be either gas or scintillation
3. May be surrounded with a hydrogenous moderator for intermediate and fast neutrons
4. A "spot" sampler collects a sample for analysis in the health physics laboratory
5. Including tritium, if required
6. Recorder and/or alarm in control room
7. Not required if film badge service is obtained on contract

there must be contamination checkers, decontamination facilities, and a covered receptacle for unreclaimable articles. Only by continuous, scrupulous care can minute, biologically insignificant amounts of radioactive materials be kept out of the shop and out of the internal structures of sensitive radiation equipment.

Radiation-measuring devices will present technical problems to instrument men until they are familiar with the new family of transducers shown in Table III.

Some instruments can be calibrated with a series of plaques having small amounts of radioactive material fixed on the surface. High-range $\gamma$ and neutron instruments, however, require intense radiation sources as well as associated shields, handling devices, and large working areas. The problems of high-level instrument calibration are sufficiently great that most installations have a separate building for this work.

It seems logical that commercial services will develop to undertake calibration of the medium- and high-range instruments used in power reactors, thereby sparing each

reactor plant the necessity of having a facility for this work. If this service becomes available, the reactor plant instrument shop will need only a few sources and jigs to obtain one or two check points on the instruments and to determine when a complete calibration is necessary.

It is well to mention in this connection two other services that it will be desirable for a power reactor plant to obtain on contract. A number of companies now offer film-badge services for $\beta,\gamma$ monitoring, and it is to be hoped that these services will be extended to neutron monitoring as well. Such services will relieve the reactor plant of the darkroom work, densitometer reading, and microscope track counting that go with a film-badge program. Urinalysis is the other service that will be of interest. The exacting chemical and physical procedures involved in these analyses lie outside the usual competence of power plant personnel, and it would seem quite uneconomic for a power plant to staff and equip a laboratory to do urinalyses on 50 to 100 people.

## INSTRUMENTATION FOR A POWER REACTOR

Measurements of radiation and radioactivity will be made throughout a power plant, particularly where men and materials leave regions of high potential contamination; measurements will be made at the points where people, equipment, spent fuel, and the various effluents leave the plant; and measurements will be made in the environment surrounding the plant. To some extent, the instrumentation will depend on the size, type, and location of the reactor, and the exact quantity and placement of instruments can be determined only by careful study of the plant layout and operational flow patterns. It is still profitable, however, to estimate the instrumentation for a representative power reactor that incorporates the features common to most plants.

The estimate given presupposes a plant with the following component parts:

1. Turbine–generator room
2. Control room
3. "Cold" laboratories and shops, including the instrument shop, and offices
4. General locker room
5. Change room for personnel decontamination and protective equipment
6. Laundry for contaminated protective equipment
7. Equipment decontamination area
8. "Hot" laboratories, shops, and caves
9. Ventilation fan and filter building, and stack
10. Active gas storage and cleanup facility
11. Active coolant storage and cleanup facility
12. Spent fuel storage, dismantling, decontamination, and shipping facility
13. Reactor building
14. Health physics laboratory
15. Environmental monitoring stations.

The proposed list of instruments is given in Table IV. The types of instruments are listed down the left side of the table, and the general locations in which measurements will be made are listed across the top of the table. The quantities of each type of instrument estimated to be required for each location are entered in the table. Fractional quantities have been used for portable and mobile instruments to indicate the relative demand that will exist for these instruments in the various locations and to obtain an estimate of the total quantities required. There are several points about the table that need explanation.

1. Any resemblance between the figures in Table IV and the instrumentation of any reactor is extremely unlikely. Many generous people have contributed lists and discussions that have made the formulation of this table possible, but it inevitably contains a large element of the author's personal judgment.

2. The table over-instruments the reactor plant. At this stage, there is no choice but to have too many instruments. It may be agreed, for example, that three instruments are needed for some particular purpose, but if the smallest number of possible locations for these instruments is five, then the minimum number of instruments for the purpose is not three, but five, and will remain so until operating experience has indicated which two are unnecessary. It will take a number of years to determine the minimum number of each type of instruments necessary for safe operation; meanwhile, all reactors will be over-instrumented because to do otherwise would be to compromise safety.

3. There are instruments listed in part C of the table that may properly be regarded as operating control instruments. As indicated, some of these report to control room recorders and a few may, in fact, actuate scram circuits. Although it may be misleading to include dual-purpose devices in a tabulation of this kind, it is better to have two groups thinking about such essential devices than it is to have no one thinking about them.

4. Finally, it must be understood that this table is presented not as a finished plan, but as a subject for the discussion and criticism without which no art can advance.

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# Supplementary Thermal Power for Hydroelectric Systems

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A HYDROELECTRIC SYSTEM must be engineered to carry the anticipated firm peak and energy loads even under "critical" water conditions. When conditions are more favorable water will therefore either have to be spilled, or at best, used to generate secondary power to be sold at dump rates, provided there is a market for it. Substantial economic gains are frequently possible through "firming up" such secondary hydroelectric power by a supplementary thermal plant. The level of firming up can be measured by the equation "Firm Up Ratio" x = firm capability—critical capability/median capability—critical capability. The higher the firm-up ratio, the greater will be the gain in firm power, and at the same time, the quantity and cost of thermal energy required. For a given set of local conditions, there will be an optimum level of firming up which will produce the greatest economic gain. The objectives are to determine the optimum firm-up ratio, the optimum size of thermal plant, and the relative economy of a gas turbine plant vs a conventional steam turbine plant for firm-up service. Equations are obtained for the desired quantities and solved on an IBM *604* computer for a wide range of hydroelectric, thermal plant, and fuel costs, using an IBM *604* computer.

Results are obtained for a system where the difference between the critical and median capability amounts to 100 million kw-hr per annum. For greater or lesser differences the economic gain and the size of the thermal plant should be adjusted in proportion, but the firm-up ratio stays the same. Fig. 1 shows that the size of the thermal plant varies directly with the firm-up ratio. The annual load factor of the thermal plant, averaged over a 10-year period, is relatively low, because the thermal plant runs only in those years when adverse water conditions occur. The low load factor explains why gas turbine plants frequently are more economical than conventional steam turbine plants for firm-up service.

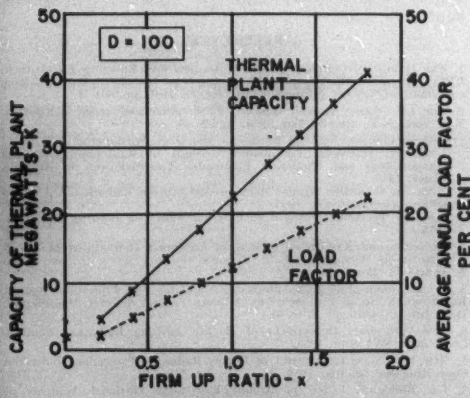


Fig. 1. Relation between capacity of thermal plant, average load factor, and firm-up ratio.

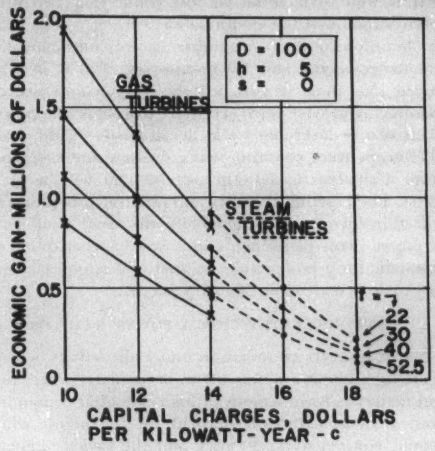


Fig. 2. Variation in maximum economic gain with thermal plant capital charges and fuel cost.

The maximum economic gain over a 10-year period corresponding to the optimum firm-up ratio and size of thermal plant is shown in Fig. 2. Where secondary hydroelectric power is all saleable, there is little economic incentive to firm it up by a supplementary thermal plant. As the value of firm hydroelectric power increases, the optimum size of the thermal plant, and the maximum economic gain increases very rapidly. For example, an increase in the cost of firm hydroelectric power from 4 to 6 mills per kw-hr produces over 370% increase in the economic gain. Doubling the fuel cost roughly halves the economic gain.

Over a wide range of hydroelectric power, thermal plant and fuel costs, unsaleable secondary hydroelectric energy can be firmed up economically through a supplementary thermal plant, even in areas where hydroelectric power is relatively cheap compared to thermal power. Apart from economic benefits through "firming up," a supplementary thermal power plant can serve to meet unexpected peak loads, and as standby in case of transmission line and hydroelectric power unit outages.

Digest of paper 57-218, "Thermal Plants for Firming Up Hydro," recommended by the AIEE Committee on Power Generation and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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# Feedback Control Systems Subjected to Large Signals

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IN FEEDBACK CONTROL SYSTEMS it is often found that a controller which has a dual mode of operation offers definite advantages. Such a controller has one mode of operation for small signals and a second mode for large signals. The first mode can usually be designed with linear studies using a periodic, aperiodic, or statistical test signal, depending on the application. A "large-step" test function is usually satisfactory, regardless of the application, for design of the second mode.

The following three items regarding system performance are obtained by methods outlined as follows: (1) the large-step response of the system when only a single mode controller is used; (2) the large-step response of the system with an "optimum" dual mode controller, neglecting the controller's dynamic properties (assuming the controller has zero response time and infinite gain); and (3) the large-step response of the system with an "optimum" dual mode controller where the dynamic properties of the controller are considered.

The difference between responses 2 and 3 is because of the dynamics of the controller. The difference between responses 1 and 3 is caused by the difference between a single mode controller and dual mode controller. The methods for obtaining these three items require the performing of three relatively simple calculations, described here as the three "evaluation tests."

The three evaluation tests to be described are all for a large-step of the same amplitude. It is therefore important at the outset to determine what is to be considered as a "large-step." If difficulty is encountered in selecting a single large-step test function, it is appropriate to use several of different amplitudes and to apply the evaluation test for each amplitude.

In a feedback-control system the controller has an algebraic maximum and minimum value of signal output that can be handled as shown in the signal-flow diagram of Fig. 1. The "forcing ability" test consists of assuming that it is possible for the controller output signal to vary between its maximum and minimum levels in a negligible time interval and then determining what the optimum transient response of the system, would be assuming an "optimum" output signal from the controller. This "optimum" controller signal is that signal which will accomplish the specified desired change of system output in a minimum time.

The forcing-utilization test is performed by introducing a fictitious external signal of constant magnitude to the point on the signal flow path indicated by Fig. 2. First the appropriate value of this external signal must be established; this is done as follows: It is considered that the closed loop system has first been subjected to the specified large-step input and has attained its steady-state response. A trial magnitude of external signal is then applied resulting in a transient; after this transient dies away, the output of the controller $\psi$ will have been modified. The particular magnitude of external test signal that results in this final controller output $\psi$ being just equal to its maximum magnitude $\psi$ max, is the appropriate magnitude to be employed in the test.

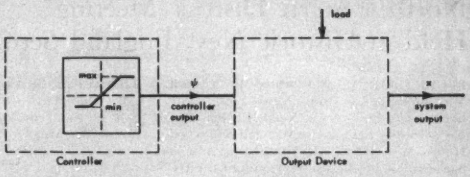


Fig. 1. The open loop element for the forcing ability text.

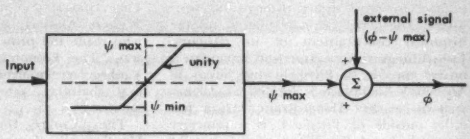


Fig. 2. Configuration for the forcing utilization test.

The actual forcing utilization test consists of removing this external signal. The transient initiated by removing this external signal is the result of interest.

The third test consists of finding the magnitude of the first overshoot in response to the large-step input applied to the system with the single mode controller. The "first overshoot" is defined as the value of that overshoot which occurs when $\dot{x} = dx/dt$ first becomes zero after the step has been applied. Mathematically negative overshoots are considered as zero overshoot.

The three desired items listed above are obtained from the three evaluation tests. Item 1 is obtained from the third test. Item 2 is identical to the result of the forcing ability test. Item 3 is obtained by plotting the forcing utilization transient as an extension of the forcing ability transient. Thus, the large-step response of the system with an "optimum" dual mode controller where the dynamic properties of the controller are considered is predicted without first determining the instrumentation for this optimum controller.

Digest of paper 57–201, "Evaluation of Feedback Control Systems Subjected to Large Signals," recommended by the AIEE Committee on Feedback Control Systems and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21–25, 1957. Published in AIEE *Applications and Industry*, vol. 76, May 1957.

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# INSTITUTE ACTIVITIES

## North Eastern District Meeting Held in Historic New England Setting

PITTSFIELD, MASS., located in western Massachusetts on the New York State border, was host to the North Eastern District Meeting held at the Wendell-Sherwood Hotel, May 1-3, 1957. Situated against a backdrop of the Berkshire Mountains, Pittsfield is the hub of a resort area that, in addition to the scenic attractions, is the home of the world famous Berkshire Music Festival at Tanglewood where each year during July and August the Boston Symphony Orchestra draws throngs of music lovers. The area is equally famous for the historical contributions of its citizenry. Josh Billings, famous American humorist, is buried outside of Pittsfield and Susan B. Anthony's birthplace is located at Adams, a town nearby. Along Route 143, a few miles outside of Pittsfield, is a cemetery in which Israel Bissell, an unsung patriot who outdid Paul Revere, lies buried. Bissell galloped five days to carry the news of Lexington to Connecticut, New York, and Philadelphia.

Located in the heart of Pittsfield is one of the finest small museums of art and natural history in the country. In a corner of the museum grounds is a marker to the Revolutionary War Easton's Tavern where plans were perfected for the capture of Fort Ticonderoga in 1775. The nearby public library contains a collection of the works, personal effects, and pictures of the author of Moby Dick, Herman Melville. The area is also known for the astronomically sized cheese (1,235 pounds) presented to President Jefferson in 1801 by the farmers of the area.

### Luncheon

The Wednesday afternoon luncheon officially opened the North Eastern District Meeting. Some of the prominent guests present included M. S. Coover, president of the AIEE; Pittsfield's Mayor Harvey Lake; and H. J. Cadwell, president of the Western Massachusetts Electric Company, who made the principal address. His topic was "The Economic Implications of the Yankee Development." J. O. Sweeny, general chairman, acted as master of ceremonies.

The "Yankee Development" to which Mr. Cadwell referred is the Yankee Atomic Electric Company's atomic power plant development at Rowe, Mass., in which his company is participating. Nuclear fuel is still not competitive with fossil fuels, he pointed out. But "we do know that 'when and if' nuclear fuels become a cheaper source of power than fossil fuels, New England will be one of the earliest beneficiaries." The possibility exists, however, of using atomic electric power in off peak hours to fill New England's reservoirs for hydroelectric generators.

"It is true, of course, that conventional steam plants are becoming larger and more efficient. This is what we mean when we say that atomic development is 'shooting at a moving target.' On the other hand, the current rise in the cost of coal and oil alongside our New England plants is tending to move the target nearer." Meanwhile, ways will have to be found to use atomic power more efficiently, such as improving load factor and selective selling.

"Off-peak storage of electric heat in water or chemicals for space heating could help a lot," he said. "Cold-water accumulators could take the peaks out of the air conditioning load. If the decremental cost of the atomic kilowatt hour is going to be as low as we all suspect, and we someday arrive at the point where efficient atomic plants are less-than-fully loaded at certain hours, we might as well use that cheap power to push water up into a reservoir. I refer, of course, to the possibility that pumped-storage plants may receive increased attention in the atomic future."

The Yankee project is expected to be completed by 1960 with an output of 134,000 kw and will exceed $35 million, which is about twice the cost of a conventional fossil-fueled steam plant of the same size.

### Inspection Trips

There were inspection trips to three Berkshire industries including Crane and Company in Dalton, who make the paper on which United States paper money is printed. The second trip was to General Electric Company's Pittsfield plants. This was an extensive three-hour tour of the power transformer and distribution transformer departments, the missile and ordnance systems department, and the chemical materials department. Highlights of the tour were the world-famous High Voltage Laboratory, the cavernous Sound Laboratory, the new "electronic brain," and some of the manufacturing operations in the construction of the giant power transformers. During an inspection trip to the Berkshire Woolen Mill in Pittsfield, the visitors were able to view the entire process of turning raw wool into finished cloth, in a large variety of types and colors for men's and ladies' wear.

### Tri-Sectional Competition

A highlight of the three-day meeting was the AIEE tri-Sectional oral and written competition. The contest between Pittsfield, Lynn, and Schenectady Sections, is designed to encourage and recognize young engineers in the presentation of technical papers. It was won by the Pittsfield team. Pritandra Chowdhuri who scored the highest individual total in the contest, and A. K. Abboushi, the other member of the Pittsfield team, received the winner's plaque

**AT THE LUNCHEON held during the AIEE North Eastern District Meeting in Pittsfield, Mass., May 1-3, were: (*left to right*) Mayor Harvey Lake, Pittsfield; J. O. Sweeney, general chairman; M. S. Coover, president of AIEE; D. E. Garr, vice-president of the North Eastern District; and W. A. McMorris, technical chairman.**

from M. S. Coover, president of the AIEE. Both men are employed by the General Electric Company.

### Student Paper Competition

In the student paper competition, R. L. Brass, a senior at Worcester Polytechnic Institute, took the first prize of $50. In addition he received a free trip to the AIEE Summer General Meeting in Montreal, Que., Canada. David Beaubien of the University of Massachusetts received the second prize and Paul Crepeau of the University of Rhode Island placed third.

### Technical Sessions

*Instrumentation.* "Instrumentation for Nuclear Power Plants" was the theme of a paper presented at this Wednesday morning session by R. C. Faught Jr., General Electric Company. Some of the characteristics affecting the design of sodium-cooled and high pressure water-cooled nuclear power plants are: pressure, temperature, decay of induced activity, corrosion, reactor temperature coefficient, and margin to boiling. The main factor to be controlled is temperature, he pointed out. "Excessive temperature will weaken the reactor structure and severe thermal stresses can arise from rapid changes in temperature," he said.

Radiation associated with the reactor and the coolant system is the major difference between a nuclear power plant and a conventional plant. Therefore, "reliability of instrument detectors is an important requirement of the nuclear power plant," Mr. Fraught emphasized. "Although the radioactive coolant system may contain protective devices, such as over-pressure valves, it is highly desirable that the control instrumentation restore the plant to normal conditions without venting radioactive coolant. The operational failure of a detector may cause a plant shutdown. Because of the nature of the plant, shutdown time is more costly and the time for replacement of equipment is longer than in conventional plants."

Other papers read at the Wednesday morning session on instrumentation were "Precise Determination of the Watt Hour," L. E. Jantos, and "Speed Measurement Recorders for Precision Mill Drives," by D. R. Hyer, of the General Electric Company.

*Transmission and Distribution.* At a Wednesday afternoon session, Messrs. F. M. Cahen and J. M. Carteron of the Électricité de France, Paris, discussed the selection by the French power industry of a new transmission voltage in their paper "The French 380-Kv System."

The necessity for a new voltage grade was felt in France about 15 years ago but nothing was done because 380-kv lines would have been wasteful at that time, it was pointed out. But since it was necessary to increase the transmission capacity of the system without building an excessive number of 225-kv circuits, 225-kv two-circuit lines were built that are convertible into single 380-kv lines by regrouping the conductors in bundles of two conductors per phase.

Inasmuch as the effective introduction of the new voltage is near, it is no longer advantageous to resort to the convertible line technique. Today, a 380-kv single line is built even though its operation at this voltage is not contemplated within the next few years.

**P. A. ABETTI (*right*), head of the Computer Section, General Electric Company, Pittsfield, Mass., chats with J. M. Carteron (*left*) of Électricité de France, Paris, France, during the AIEE North Eastern District Meeting. As guest of General Electric and AIEE, Mr. Carteron presented two technical papers concerning the French electric power industry. Co-author of the papers was F. M. Cahen also of Électricité de France.**

Other papers included "Some Aspects of Surface Voltage Gradient on Power Transmission Lines," H. B. Dwight, Massachusetts Institute of Technology, and "12.47-Kv Distribution in Southern New England," P. S. Shelton, Narragansett Electric Company.

*Communication and Electronics.* In an unusually interesting session on Thursday morning, a group of provocative papers were read that ranged from propogation of radio waves via the troposhere to the latest transistor applications.

"Review of Potential Applications of Semiconductor Devices in Television Receivers," by W. F. Palmer and G. Schiess, both of Sylvania Electric Products, Inc., stirred a lively discussion.

With the growing frequency response and increasing power capabilities of transistors, the possibilitiy exists within the next few years of applying transistors to television circuits, the author pointed out. The advantages of transistors in television applications are the following: heat problem will be reduced especially in portable receivers, efficiency of transistors may open the way to battery operated portable receivers, receivers can be made more compact, and the over-all reliability of the television receiver will be improved. The RF amplifiers and oscillator sections are the main stumbling blocks in the transistorization of the television receiver, it was stated.

*Survey of Computers and Their Applications.* The theme of this Thursday afternoon session was expertly expounded by E. L. Harder of Westinghouse Electric Corporation. He discussed "The Computing Revolution," pointing out the significant developments in computing during the past year in engineering applications, automatic programming, simulation, analog versus digital computers, and business and control applications (text appears in *Electrical Engineering*, June, pp. 476-81; July, pp. 586-90). The 10-to-1 increase per year in computing power as measured by the speed, size of fast memory, power of command, flexibility, and reliability, shows no sign of diminishing, he emphasized. "It requires little imagination to realize the vast potentialities in this direction that remain unexplored as the power of mechanized logic and computer developments are brought to bear on sequencing and optimizing controlled processes."

The author pointed out that information processing bears the same relation to man's thinking process or his mental work as the application of physical power does to his physical work. "The implications of information processing are quite as far reaching as power and the tremendous stimulation to automatic processing provided by the digital computer is producing nothing less than a revolution in this area." It is hoped, he said, that engineers can keep this one under better control than the last industrial revolution.

*Programming and Engineering Applications of Digital Computers.* S. G. Fleming of the General Electric Company in her paper "Automatic Programming for Digital Computers," at the Friday morning session, pointed out the misleading connotation associated with the word "automatic" where it describes the electronic data processing machines in use today. Frequently, the successful execution of a program is the result of many long hours of bookkeeping, coding, and desk checking.

Automatic programming is needed, nevertheless, inasmuch as it cuts down the training period required for programmers and makes programming an easier task. This

**FOLLOWING the North Eastern District Meeting Student Paper Competition (above, *left*), AIEE President M. S. Coover (*second from left*) presents a $50 check to R. L. Brass (*right*), a senior at Worcester Polytechnic Institute, winner of first prize. Looking on are Paul Crepeau (*left*) of the University of Rhode Island who placed third, and second prize winner David Beaubien (*second from right*) of the University of Massachusetts. *Above, right:* President Coover (*center*) presents the winner's plaque to the Pittsfield, Mass., team, victors for the second straight year over the Lynn, Mass., and Schenectady, N. Y., Sections in the AIEE tri-Sectional oral and written competition held during the North Eastern District Meeting. Pritandra Chowdhuri (*left*), who scored the highest individual total in the contest, and A. K. Abboushi (*right*) are both of the General Electric Company in Pittsfield. The contest is designed to encourage and recognize young engineers in the presentation of technical papers.**

is necessary from an economic point of view inasmuch as a large-scale computer costs about $30,000 and the cost of programming varies from $5 to $10 per computer instruction.

Although no method of automatic programming eliminates all careless programming errors, the vast majority of large-scale computer installations has found that the advantage of an automatic system far outweigh the disadvantages, she pointed out.

*Nuclear Power Generation.* At the final session held Friday afternoon, "The Effect of Nuclear Power on Future Power Systems," a paper by A. G. Mellor, General Electric Company, was of unusual interest in view of the approaching use of commercial atomic power.

The author attempted to assess the possible effects of nuclear power on future power systems. The following factors should be considered, he said: the effect of the introduction of nuclear power on power system economies, the possible methods of operation of nuclear power plants and their effect on present and future conventional generating facilities, the effect of the introduction of nuclear power on generating station location, and the required characteristics of nuclear power plants for satisfactory operation on large power systems.

The author concluded that nuclear power plants will eventually become cheaper than conventional power plants but there is no prospect of a reduction to the ultimate consumer. In addition, the building of new nuclear powered generating stations will not make existing generating stations obsolete.

# Aircraft Applications Stressed at AIEE Joint District Meeting in Dayton

AIRCRAFT APPLICATIONS were stressed at the AIEE East Central and Middle Eastern District Meeting and Air Transportation Conference held May 7-9, 1957, at the Dayton-Biltmore Hotel, Dayton, Ohio. Registration at this combined meeting exceeded 900.

In conjunction with the meeting, an exhibition of aircraft components was held during the three-day period, featuring displays by more than 30 manufacturers.

Approximately 70 papers were presented at the 15 technical sessions, with the emphasis upon the electrical engineering aspects of air transportation.

At the luncheon and general session held Tuesday, May 7, D. N. Warren, general chairman, presided. He introduced Henry Stout, Dayton's mayor, who extended a warm welcome to the assembly. AIEE President M. S. Coover then presented a short address. The keynote speech "Is the Engineer a Professional?" was presented by L. T. Rader of the General Electric Company. The text of this address appears on pp. 568-70 of this issue of *Electrical Engineering*.

A number of inspection trips were made to various manufacturing plants and other points of interest in the Dayton area. Included were trips to the Air Force Central Museum, Allison and Delco Products Divisions of the General Motors Corporation, National Cash Register Company, Eastern Motor Division of the A. O. Smith Corporation, Airtemp Division of the Chrysler Corporation, Armco Steel Corporation, and several laboratories at the Wright-Patterson Air Force Base.

The District 11 Student Prize Papers Contest was held on Wednesday, May 8, and the winners were announced at the banquet that evening. First prize of $50 and the District trophy was awarded to E. T. Wright of the University of Akron for his paper "A Simple Wide-Range Pulse Generator." J. E. Dering of the University of Toledo won the second prize of $40. The third prize of $25 went to John Hyde and Vincent Orlando of the University of Cincinnati.

### Technical Session

*Aeronautical Lighting.* At a Tuesday morning session on lighting, W. T. Harding of the Wright Air Development Center presided. The first paper presented was "Lighting Design for Modern Aircraft" by P. H. Greenlee of the Grimes Manufacturing Company of Urbana, Ohio. The paper is devoted primarily to a discussion of the problems involved in exterior lighting on an airplane, but also touches briefly on the types of lighting now being used inside the airplane.

"Lighting for Tomorrow's Aircraft" by M. A. Mortensen and J. W. Tuttle of the General Electric Company discusses the problems involved in "split-second seeing," vitally needed for the operation of modern aircraft.

P. E. Massie of Day-Ray Products, Inc., South Pasadena, Calif., described how lighting research and use of alternating voltage contribute to the lighting of modern commercial aircraft.

The requirements for jet aircraft cockpit layouts were discussed in a paper by S. N. Roscoe of the Hughes Aircraft Company, Culver City, Calif.

The session closed with a paper by Ben George of Airmark Plastics Corporation, North Hollywood, Calif., covering the development and testing of plastic control panel lighting.

*Management.* H. E. Deardoff of the Dayton Power and Light Company presided at a Tuesday afternoon session on management. The first paper presented was "Management in a Manufacturing Organization" by F. E. Harrell of the Curtiss-Wright Corporation, Cleveland, Ohio. Emphasis was placed on three points of which the author believes the management job consists: motivation, appreciation, and compensation.

Lt. W. R. Greenwood of the Wright Air Development Center discussed the use of servomechanism theory in applying linear programming to business problems. He stated that "the theory of servomechanisms can help decision-making in two ways: It can provide an analytical model for the research staff to use in setting up computer programs that can involve large-scale computation of complex problems in resource allocation, and it can help the executive directly by providing him with a sharp analytical tool that will aid his thinking by clarifying concepts."

"The Development of Management Capabilities Among Practicing Engineers" by A. J. Morgan of the University of Dayton Research Center discusses the growing necessity for the use of technically trained personnel in managerial positions, and the qualifications necessary for the handling of these positions.

*Rotating Electrical Machinery.* Three papers were presented at a Wednesday morning session on rotating machinery at which A. E. Hartman of Robbins and Myers, Inc., presided. The first paper was "Two-Reaction Theory of a General Induction Machine and Its Equivalent Circuit" by Y. H. Ku and D. W. C. Shen of the University of Pennsylvania.

In "The Dilemma of Single-Phase Induction Motor Theory," P. L. Alger of General Electric compared some of the various theories on induction motor operation and pointed out their virtues and shortcomings. The paper also includes the well-known double rotating field and cross flux theories, as well as the constant flux leakage theory proposed by the late Dr. C. P. Steinmetz. A companion paper presented by Edward Bretch of the Century Electric Company, St. Louis, Mo., describes the Steinmetz conception in detail.

*Aircraft Systems.* G. W. Sherman of the Wright Air Development Center presided at one of the Wednesday afternoon sessions on aircraft systems. William McDonell of Lockheed Aircraft Corporation presented a paper entitled "Parallel A-C Generators on a Common Drive." This method of operating alternators gives multigenerator reliability with a minimum of weight, by eliminating speed-regulating devices and bus-transferring equipment.

A paper was presented by Lt. R. E. Thomas of the Wright Air Development Center on the stability of aircraft d-c power systems with inverter loads. The paper describes a mathematical model devided in terms of measurable properties of the system, and by correlating results obtained from the model with laboratory tests,

## Future AIEE Meetings

**Pacific General Meeting***
Pasco, Wash.
August 28-30, 1957

**AIEE Magnetic Amplifiers Conference***
Penn-Sheraton Hotel,
Pittsburgh, Pa.
September 4-6, 1957

**Petroleum Conference**
Penn-Sheraton Hotel,
Philadelphia, Pa.
September 9-11, 1957
*(Final date for †TP—Closed, ‡CP Syn.—Closed, CPMs'—July 5)*

**AIEE-IRE Industrial Electronics Symposium**
Morrison Hotel, Chicago, Ill.
September 24-25, 1957
*(Final date for †TP—Closed, ‡CP Syn.—July 10, CPMs—July 19)*

**AIEE-IRE-IIT-NU-U of I National Electronics Conference**
Hotel Sherman, Chicago, Ill.
October 7-9, 1957
*(Final date for †TP—July 7, ‡CP Syn.—July 22, CPMs—Aug. 1)*

**Fall General Meeting**
Chicago, Ill.
October 7-11, 1957
*(Final date for †TP—Closed, ‡CP Syn.—July 24, CPMs—Aug. 2)*

**Reliability and Quality Control in Electronics Conference**
Silver Spring, Md.
October 10, 1957
*(Final date for †TP—July 10, ‡CP Syn. July 25, CPMs—Aug. 2)*

**Feedback Control Conference**
Chalfonte-Haddon Hall Hotel
Atlantic City, N. J.
October 16-18, 1957
*(Final date for †TP—July 16, ‡CP Syn.—July 31, CPMs—Aug. 10)*

**EJC-ECPD Engineers General Assembly**
Hotel Statler
New York, N. Y.
October 24-25, 1957

**Machine Tool Conference**
Hotel Schroeder,
Milwaukee, Wis.
November 4-6, 1957
*(Final date for †TP—Aug. 5, ‡CP Syn.—Aug. 20, CPMs—Aug. 30)*

**Magnetism and Magnetic Materials Conference**
Park Sheraton Hotel,
Washington, D.C.
November 18-20, 1957
*(Final date for †TP—Aug. 19, ‡CP Syn.—Sept. 3, CPMs—Sept. 13)*

**AIEE-IRE-ACM Eastern Joint Computer Conference**
Park Sheraton Hotel,
Washington, D.C.
December 8-11, 1957
*(Final date for †TP—Sept. 9, ‡CP Syn.—Sept. 24, CPMs—Oct. 4)*

**Winter General Meeting**
Hotel Statler,
New York, N. Y.
February 2-7, 1958
*(Final date for †TP—Nov. 1, ‡CP Syn.—Nov. 15, CPMs—Nov. 25)*

**EJC Nuclear Congress**
International Amphitheater,
Chicago, Ill.
March 17-21, 1958
*(Final date for †TP—Dec. 17, ‡CP Syn.—Jan. 1, CPMs—Jan. 10)*

**South West District Meeting**
Tulsa, Okla.
March 31-April 2, 1958
*(Final date for †TP—Dec. 31, §DP Syn.—Jan 14, DPMs—Jan. 24)*

**Middle Eastern District Meeting**
Washington, D.C.
April 28-30, 1958
*(Final date for †TP—Jan. 28, §DP Syn.—Feb. 11, DPMs—Feb. 21)*

**Great Lakes District Meeting**
East Lansing, Mich.
May 5-7, 1958
*(Final date for †TP—Feb. 5, §DP Syn.—Feb. 18, DPMs—Feb. 28)*

**East Central District Meeting**
Huntington, W. Va.
May 13-15, 1958
*(Final date for †TP—Feb. 13, §DP Syn.—Feb. 28, DPMs—March 10)*

**Summer General Meeting**
Buffalo, N. Y.
June 23-27, 1958
*(Final date for †TP—March 21, ‡CP Syn.—April 8, CPMs—April 18)*

**Pacific General Meeting**
Sacramento, Calif.
August 19-22, 1958
*(Final date for †TP—May 19, ‡CP Syn.—June 3, CPMs—June 13)*

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CP Syn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscript
(The DP Syn. date is 10 days before the DPMs date)

it was possible to verify the model and obtain the necessary requirements.

In a paper by R. J. Rindt and R. D. Jessee of the Westinghouse Electric Corporation, a method of fault analysis for a-c aircraft electric power systems is discussed. The technique presented is to set up passive elements of an ANACOM network analyzer to represent the elements of the power system and to use an electronic differential analyzer to represent the regulators of the system.

Other papers presented included "A Method of Determining the Input Power Requirements of Aircraft Generators" by T. B. Owen of the Douglas Aircraft Company, Inc., and "Reactive Phenomena in 3-Phase Half-Wage Magnetic Amplifiers with Inductive Load" by H. M. McConnell of Jack & Heintz, Inc.

*Power Generation.* W. T. Beatson of the Bureau of Aeronautics, U. S. Navy, presided at one of the Thursday morning sessions devoted to power generation. In the first paper presented, A. Krausz of Jack & Heintz, Inc., discussed the use of pulse gate control as applied to 3-phase magnetic amplifiers.

"Salient-Pole Permanent-Magnet Alternators for High-Speed Drive" by A. T. Puder and Fritz Strauss stresses the construction and the design problems of some of these units recently built and tested in production. Rated outputs up to 10 kva have been realized at speeds up to 24,000 rpm. Even greater outputs and speeds have been achieved in experimental machines.

L. G. Hector of the Sonotone Corporation described a new nickel-cadmium rechargeable battery which uses sintered nickel powder plates for grids, film or woven plastics for separators, and either molded plastics or steel for cell cases.

A paper entitled "Regulator-Exciter Systems for Small Missile and Aircraft Power Supplies" by H. S. Sechrist and H. G. Carlson of General Electric describes a magnetic-amplifier type regulator-exciter for a 5-kva 12,000-rpm 115/200-volt 400-cycle synchronous generator, designed to meet the requirements of small size, light weight, and rugged construction.

The last paper presented at the session was "Generator Torque Calculations" by D. S. Toffolo of the U. S. Naval Research Laboratory. In this paper a technique is described which makes it possible, in airborne parallel electric systems, to determine the position of a control link as a function of the generator load current and the generator power factor, given the input and output speeds of the drive.

# Plans Nearing Completion for 1957 AIEE Pacific General Meeting

PLANS for the 1957 AIEE Pacific General Meeting to be held in Pasco, Wash., August 28-30, are nearing completion. The technical program will present a view of several highly interesting fields which are the subject of intense research and development programs at this time. The inspection trips and entertainment programs will offer many excellent opportunities for engineers and in some instances family groups to get a look at the rapidly expanding engineering, industrial, and recreational features of the Northwest.

O. W. Hurd, general chairman, has a team of engineers at work making a calculated effort to strain your brains and monopolize your time and pack your memory with memorable events and opportunities.

H. A. Carlberg, general vice-chairman, has arranged for an outstanding authority in the nuclear power application field to open the meeting with a discussion of some of the outstanding problems in the atomic energy field.

*Walla Walla District, Corps of Engineers, Photo*

**THE ICE HARBOR DAM construction site, Snake River, Wash., will be visited by AIEE members during one of the inspection trips held at the 1957 Pacific General Meeting, August 28-30.**

### Entertainment

R. B. Britton, entertainment chairman, has plans to appeal to all ages and interests and there will be plenty of the flavor of the West. Better bring along your "shootin' irons pardner," slide rules will be of no help.

### Ladies Events

Mrs. C. R. Bergdahl, chairman, has many interesting events and tours worked out to keep the families of engineers occupied. In most instances, the programs are family centered in anticipation of a relatively large number of family groups. During August, the Northwest is especially attractive to family groups because the population finds most of their interests centered around outdoor events.

### Hotel Reservations

F. P. Robinson, chairman, has arranged for large numbers of hotel and motel reservations and Registration Chairman Phil Reinig has a smooth working team to take care of the needs of all persons who attend. There will be a wide variety of types of accommodations and locations. Most of the hotels and motels are relatively new or new, and are well located for the convenience of the users. Persons driving to the meeting will find that parking is not a problem. Reservations will be handled on a first-come first-served basis and members are urged to make advanced reservations with a stated preference for hotels or motels.

### Inspection Trips

H. A. Broderson, chairman, has arranged for several inspection trips during the meeting. The trips will include local major components of the Pacific Northwest power developments. McNary Dam, Locks, and Powerhouse; Ice Harbor Dam construction site; and Midway 230-kv switching station will be visited. The buses to Midway will pass through the reservation area of the Atomic Energy Commission Hanford Works.

### Technical Program

W. J. Dowis, chairman, has worked closely with AIEE to develop an outstanding technical program including sessions on nucleonics, nuclear radiation instrumentation, and related atomic subjects; psychology in design and human engineering; electric generation, transmission, distribution, relaying, and utilization; wire and radio communications; magnetic amplifiers; domestic and commercial applications; and safety. It is believed that engineers will find the program offers ample variety to suit their interests.

### Students

D. W. McLenegan, chairman, is arranging a program on the theme of early professional development of young engineers. A luncheon meeting is planned for stu-

dents, as well as a conference for faculty advisors of student branches.

**Weather**

Visitors will be pleasantly surprised by the Pasco Basin semi-arid climate and average humidity of 35. The August temperature averages are 90 high and 60 low. The dry air practically eliminates sensible perspiration and creates a chilly feeling at night. The warm days always have gentle winds.

It is the accepted custom to wear sports shirts for both work and play. All summer social activities are informal and generally held outdoors.

## "Industrializing the Atom" Is Theme of 1958 Nuclear Congress

"Industrializing the Atom" will be the theme for the 1958 Nuclear Congress now definitely set for March 17-21 at the International Amphitheater in Chicago, Ill. With plans well under way, sessions are tentatively scheduled to cover economics, finance, future plans, and many other facets.

All engineers and scientists working in the nuclear field are urged to contribute one or more papers. There were 158 papers from all aspects of nuclear science and engineering at the 1957 Congress in Philadelphia, Pa. Abstracts are due by July 15, 1957, and authors should get in touch immediately with the Secretary of their particular Society, or the Society most closely connected with their subject. All papers are being handled by individual societies and not by the Engineers Joint Council (EJC). All societies in any way connected with the nuclear field are urged to submit papers, whether or not they are affiliated with EJC.

Co-ordinated by EJC, for its member societies, managed by American Institute of Chemical Engineers (AIChE) and sponsored by the engineering and scientific societies interested in the nuclear field, the 1958 Nuclear Congress promises to be bigger than ever. Once again the Hot Laboratories and Equipment Conference, and the National Industrial Conference Board's Atomic Energy in Industry Conference will be a part of the 1958 Nuclear Congress.

A major part of the Congress will again be the International Atomic Exposition where engineers, scientists, and management men can see and discuss with industrial representatives, all nuclear processes and materials currently available. At Philadelphia in 1957, a total of 16,429 engineers, managers, and scientists attended the Exposition. With the advances a year can bring to the rapidly growing industry, the 1958 Exposition should attract many more.

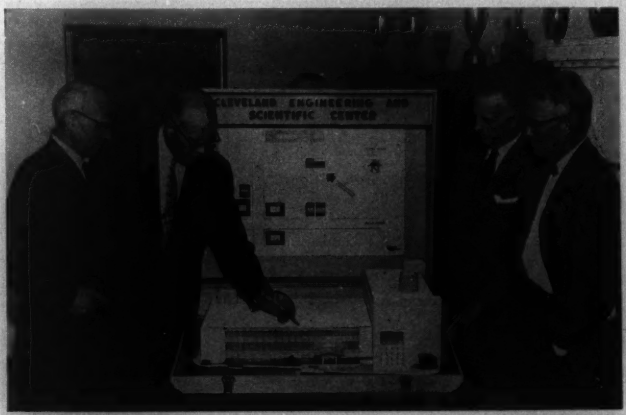
Under the leadership of J. R. Dunning, chairman of the Nuclear Congress Policy Board, B. R. Prentice, chairman of the General Committee, and J. W. Landis, chairman of the Nuclear Engineering and Science Conference (NESC) Committee, the 1958 Nuclear Congress is expected to mirror all the advances of the nuclear field. Authors are again urged to submit their proposed papers to their societies as soon as possible.

## New York Section Officers

*Courtesy Ross Photos*

**OFFICERS of the New York Section of AIEE for the year 1957-58 include: (*seated, left to right*) W. G. Vieth, Section secretary; W. T. Rea, Section vice-chairman; R. W. Gillette, Section chairman; W. A. Clark, past chairman (1956-57); L. F. Stone, vice-president, District No. 3; M. L. Gardner, chairman, Transfers Committee; (*standing, left to right*) J. J. Anderson, chairman, Publicity Committee; A. H. Zemanian, chairman, Basic Science Division; J. R. Rankin, chairman, student activities, District No. 3; J. C. Hoyt, member-at-large; C. I. Hubert, chairman, Transportation Division; G. H. Needham, chairman, New Jersey Division; and J. R. Kerner, secretary, District No. 3.**

## Cleveland Engineering Center




*Courtesy Robman*

**W. H. CHASE (F '51) of the Ohio Bell Telephone Co. (*second from left*), retiring president of the Cleveland Engineering Society, shows the newly elected officers details of the $1.52 million Cleveland Engineering and Scientific Center which the society is constructing. The new officers of the society are (*left*) First Vice-President R. H. Smith (M '36), secretary, Reliance Electric & Engineering Co.; President W. C. Brown (*second from right*), manager, application engineering, Large Lamp Division, General Electric Company; and Treasurer H. G. Cannon, Jr. (*right*), supervisor, manufacturing operations, Standard Oil Co. (Ohio). The Center will be ready for occupancy and use by more than 50 technical and business groups in the area by May 1958.**

## Solid-State Devices Conference

**THREE SPEAKERS** of the Special Technical Conference on Solid-State Dielectric and Magnetic Devices confer during the demonstrations presented in the Electrical Engineering Laboratories at Catholic University, Washington, D. C. The speakers were (*center of photograph, left to right*) Wolf Kuebler, H. H. Wieder, and C. F. Pulvari. The conference, held April 22-23, 1957, was sponsored by AIEE and the Institute of Radio Engineers (IRE).

## Petroleum Executive Committee

**AMONG THOSE** who attended the Petroleum Industry Conference Executive Committee Meeting in Philadelphia, Pa., March 12, were (*seated, left to right*) Sam Axe, vice-chairman, 1957 AIEE Petroleum Industry Conference; R. S. Gardner, assistant secretary, technical activities, AIEE Headquarters; J. Z. Linsenmeyer, past chairman, AIEE Petroleum Industry Committee; A. L. R. Maynard, chairman, 1957 AIEE Petroleum Industry Conference; and (*standing*) R. S. Cannon, chairman, AIEE Petroleum Industry Committee. The 1957 Petroleum Industry Conference will be held September 9-11 at the Sheraton Hotel in Philadelphia. The annual conference is national in interest, technical in character, and concentrated as to subject matter on the three branches of the petroleum industry—production, refining, and transportation.

## EJC Issues Annual Report for 1956

Engineers Joint Council (EJC) has recently issued its Annual Report for the year 1956.

The 40-page publication begins with "The President's Report," a brief review of significant achievements and highlights of the past year. Among the points mentioned is the great interest shown in the Second Annual Assembly of EJC, indicating "the place which EJC can fill in providing such a forum for discussion of topics of concern to all engineers."

In reference to EJC's standing and task committees and commissions, mention is made of the efforts of the Engineering Manpower Commission which resulted in the establishment by President Eisenhower of the National Committee for the Development of Scientists and Engineers, which the president of EJC is one of two engineering representatives. The first interim report of the National Committee is contained in Appendix 2 of the EJC Annual Report.

Other committee work mentioned includes the sponsorship by the Public Relations Committee of an EJC newsletter, entitled "Engineer," and the completion of the EJC report, "Professional Standards and Employment Conditions," which has received wide circulation since it was issued in March.

Also briefly reviewed are joint undertakings with Engineers' Council for Professional Development (ECPD) including a proposal for a survey of the engineering profession which is contained in Appendix 3 of the Annual Report.

Following the President's Report are the individual reports of the EJC committees which present details of the work accomplished.

The constitution and bylaws make up Part Two of the report. Part Three lists the committees and committee members for 1957 and Part Four of the Annual Report is a Directory.

## Two AIEE Fellows Elected to Eta Kappa Nu

C. G. Veinott (F '48) and H. J. Dibble (F '40), of the AIEE Cleveland Section, have been elected to membership in the Eta Kappa Nu Association. The membership awards were conferred at the April 18, 1957, initiation ceremony of the Zeta Chapter (Case Institute of Technology) of Eta Kappa Nu. In each case, the citation reads ". . . in recognition of his attainments and services in the advancement of the Science of Electricity and of the Profession of Electrical Engineering."

Mr. Dible is a graduate of the University of Pittsburgh and is employed as transmission and protection engineer for the Ohio Bell Telephone Company, Cleveland, Ohio.

Dr. Veinott holds bachelor and doctorate degrees from the University of Vermont and is responsible for advance a-c design at the Reliance Electric and Engineering Co., Cleveland, Ohio.

## Michigan Section Holds Annual Spring Dinner Meeting

Members and guests of the Michigan Section of the AIEE held their annual Spring dinner meeting at Michigan State University, East Lansing, on April 9, 1957.

Prof. I. B. Baccus, Michigan State University, past chairman of the Michigan Section, gave the invocation preceding the dinner. Section Chairman F. Von Voigtlander announced the newly elected officers and directors who are: Prof. H. M. Hess, Wayne State University, chairman; B. H. Schneider, Detroit Edison Company, vice-chairman; and J. W. Eakins, Jesse W. Eakins Company, secretary-treasurer. Directors selected were: H. S. Mika, Ford Motor Company, Dearborn; C. R. Seibert, Detroit Edison Company; R. F. Noonon, Michigan State University; R. L. Calkins, Pennsylvania Salt Company, Wyandotte; J. G. Tarbaux, University of Michigan; and J. J. Fredrickson, General Electric Company, Jackson.

Included in the attendance of 90 were 18 electrical engineering students.

Program Chairman W. M. Smith, Consumers Power Company, introduced A. L. Simberg, supervisor of personnel research and development of A-C Spark Plug Division of General Motors Corporation, who gave a very interesting talk on "Creativity." Mr. Simberg stated: "Certainly one of the most important factors in keeping a company competitive today is the number and quality of new ideas it has regarding product and process design." He then briefly described a complete program in the area of creative thinking which has been undertaken by the A-C Spark Plug Division of General Motors in an effort to encourage creative activity.

**THE AIEE MICHIGAN SECTION held its annual Spring dinner meeting April 9, 1957. At the head table were *(left to right)* K. B. Norris, of the Section Entertainment Committee; W. M. Smith, program chairman; A. L. Simberg, speaker, A-C Spark Plug Division; F. Von Voightlander, chairman, Michigan Section; I. B. Baccus, past chairman, Michigan Section; H. M. Hess, chairman elect, Michigan Section; W. C. Peterson, of the Contact Committee; and M. B. Rann, of the Public Relations Committee.**

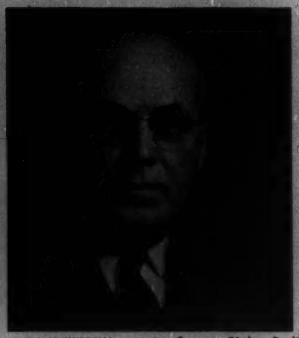
## B. H. Zacherle Installed as Philadelphia Section Chairman

B. H. Zacherle, a senior engineer of United Engineers & Constructors, Inc., has been installed as chairman of the Philadelphia Section of the AIEE. Other officers installed are: Vice-Chairman G. B. Schleicher, senior engineer of the Meter Division of the Philadelphia Electric Co.; Secretary R. S. Hewett, chief of the Application Engineering Section (Government and Institution Industries), Minneapolis-Honeywell Reg. Co.; and Treasurer H. U. Davis, specifications engineer for the Western Pennsylvania Territory of the American Telephone & Telegraph Co. Installed as members of the Board of Directors are: M. L. Stoughton, I-T-E Circuit Breaker Co.; R. R. Wagstaff, United Engineers & Constructors, Inc.; D. R. Boone, Westinghouse Electric Corporation; W. S. Osborne, Atlantic Refining Co.

Dr. R. P. Brecht, professor of industry at the University of Pennsylvania's Wharton School, spoke at the initial meeting of the newly formed Management Division of the Philadelphia Section which was held in conjunction with past-chairman's night on May 13. Dr. Brecht's talk on "Supervising the Younger Engineer" delved into the problems peculiar to today's younger engineers as contrasted to those in existence prior to World War II. He stressed the importance of allowing each engineer to exhibit personal initiative within the overall framework of conformity. Dr. Brecht maintained that a competent engineer is not necessarily a good executive. He urged intensive management training for all supervisors.

The April 8 Main-Section meeting featured a talk by Jorgen Jensen, group engineer, air defense development, Glenn L. Martin Co., Balitmore, Md. Mr. Jensen covered the problems of continuously tracking the Earth Satellite, which is to be launched later this year, and of obtaining information from its various instruments. He discussed the electronic components and power-producing devices within the satellite itself, as well as the communication of information, through space, via radio transmission. Mr. Jensen described the problems that arose due to temperature extremes and severe shocks and vibrations.

**NEW OFFICERS of the Philadelphia Section of AIEE are: *(left to right)* Vice-Chairman G. B. Schleicher, Philadelphia Electric Co.; Treasurer H. U. Davis, American Tel. & Tel. Co.; Chairman B. H. Zacherle, United Engineers & Constructors, Inc.; Retiring Chairman M. J. A. Dugan, General Cable Corp.; and Secretary R. S. Hewitt, Minneapolis-Honeywell Reg. Co.**



*Courtesy Gladser Studio*

**H. A. LOTT, executive engineer and manager of planning department, Southern California Edison Company, newly elected chairman of the Los Angeles Section of the AIEE.**

*Photo by Haines*

**E. D. BARCUS, toll service transmission engineer, Pacific Telephone and Telegraph Company, newly elected vice-chairman of the Los Angeles Section of the AIEE.**

## Los Angeles Section Announces New Officers

Election was held recently of officers of the Los Angeles Section of AIEE for the fiscal year starting June 1, 1957. The Los Angeles Section, consisting of approximately 3,500 members, cast 1,048 ballots and elected officers as follows: Chairman— H. A. Lott, executive engineer and manager of planning department, Southern California Edison Company; Vice-Chairman—E. D. Barcus, toll service transmission engineer, Pacific Telephone and Telegraph Company; Secretary-Treasurer—Fred Foulon, electronic engineer, Douglas Aircraft Company.

Elected Members of the Executive Committee are: F. W. Bowden, J. H. Drake, Willis Johnson, and Robert Milmoe.

Other officers include: Chairman, Boulder City Subsection—W. K. Imhoff, Southern Nevada Power Company; Chairman, Riverside–San Bernadino Subsection—C. N. Parker, California Electric Power Company; Aircraft Division Chairman—G. B. Saucerman; Basic Sciences Division Chairman—Ellis King; Communications Division Chairman—T. J. Fleming; Electronics Division Chairman—G. J. Jelnicker; Power Division Chairman—C. B. Bennett; Management Division Chairman—L. W. Swanson; Young Engineer Division Chairman—P. F. Paul; Magnetics Division Chairman—R. C. Byloff; and Industry and Construction Division Chairman—E. L. Frumhoff.

The Section's outgoing chairman, P. L. Savage, introduced the newly elected officers to the Section at the annual Ladies' Night dinner meeting, which was held May 14, 1957, at the Oakmont Country Club. The principal speaker of the evening was Dr. P. S. Smith, president of Whittier College, who gave an excellent talk on "Our American World in 1957." Dr. Smith's friendliness and his unusual ability to flavor a serious subject with the spice of humor made the program an outstanding event of the year.

**TWO of the newly elected officers of the North Carolina Section of AIEE are W. J. Wortman (*left*), Duke Power Company, Section vice-chairman; and Prof. W. D. Stevenson (*right*), North Carolina State College, Section chairman.**

## Gift of Stock Presented to Engineering Foundation

Another boost to engineering and scientific research is announced by Engineering Foundation, whose endowment fund recently has been increased by 100 shares of General Motors Stock, the generous gift of Prof. O. W. Boston, of Ann Arbor, Mich. Prof. Boston, a fellow of the American Society of Mechanical Engineers and distinguished educator, directed that the stock is to be invested by United Engineering Trustees, Inc., custodian of the Foundation's funds, and the income from it "used for the furtherance of research in science and engineering."

Prof. Boston's gift to Engineering Foundation typifies the growing awareness of the individual engineer of the need for more engineering and scientific research and of the vital role the Foundation plays in stimulating and supporting research programs. Established in 1914, Engineering Foundation was a pioneer in recognizing the need for research in the sciences and engineering. Its current endowment fund is in the neighborhood of $1.5 million.

## AIEE Magnetics Subcommittee Plans Conference in November

A Conference on Magnetism and Magnetic Materials will be held in Washington, D. C., on November 18-20, 1957, sponsored by the AIEE in co-operation with the American Physical Society, American Institute of Mining and Metallurgical Engineers, Institute of Radio Engineers, and the U. S. Office of Naval Research.

Authors should submit titles of proposed papers by July 1 and abstracts by August 15. For further details, write: L. R. Maxwell, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

## New Officers Elected by AIEE North Carolina Section

At the semiannual spring meeting in Asheville on May 3, the North Carolina Section of the AIEE elected their officers for the 1957-58 year.

Elected to the post of chairman was Prof. W. D. Stevenson of North Carolina State College; for vice-chairman, W. J. Wortman, Charlotte; and secretary–treasurer, C. R. Webster, Raleigh. Elected for executive committee members at large were C. E. Harris, Charlotte; and S. W. Kirkman, Winston-Salem.

Both Mr. Wortman and Mr. Harris are with the Duke Power Company, Charlotte. Mr. Wortman is assistant to the manager of operations and Mr. Harris is supervisor of relays.

Technical papers were presented during

the all-day session and an after dinner address was made by H. L. Crutcher, meteorologist of the National Records Center. Mr. Crutcher described the effects of weather on the course of history. He pointed out that the sun was the source of all weather for the earth, and that it was expected that the sun's activity for this year would be the greatest for this century.

## Sixth Annual Industrial Electronics Symposium Planned

The sixth annual Industrial Electronics Symposium, cosponsored by the AIEE and the Institute of Radio Engineers (IRE) Professional Group on Industrial Electronics, will be held September 24-25, 1957, at the Morrison Hotel, Chicago, Ill.

The symposium will cover the development of transducers and other elements of industrial electronic systems, and integrated systems for industrial electronic control.

In the past, these annual meetings have been rotated between Cleveland, Ohio; Detroit, Mich.; Pittsburgh, Pa.; and Chicago, Ill.

This year's meeting promises to be one of the best due to the recent advances in the field. Plan to attend.

## Two AIEE Members Receive Engineering Medals

Two AIEE members were among the winners of awards and prizes presented at the annual meeting of the Engineering Institute of Canada, June 14, at the Banff Springs Hotel, Banff, Alta., Canada.

A medal perpetuating the memory of a famous engineer, Sir John Kennedy, awarded for ". . . outstanding merit in the profession," was presented to R. L. Hearn (M '23) of Toronto, Ont., consulting engineer to the Hydro Electric Power Commission of Ontario.

The Ross Medal for a paper on an electrical subject was presented to W. R. Way (F '53) of Montreal, Que., a vice-president of the Shawinigan Water and Power Company. His paper was "Growth and Development of Large Electrical Systems."

## New Executive Editor of *Civil Engineering* Appointed

The American Society of Civil Engineers (ASCE) has announced the appointment of H. W. Hunt as executive editor of its official magazine, *Civil Engineering*.

For eight years in the 1940s Mr. Hunt was associate editor of *Engineering News-Record*, writing in the construction, business, and labor relations fields. He also had a wide variety of construction experience with contractors and engineers, in both field and office.

A civil engineering graduate of the University of Iowa, Mr. Hunt began his professional career with the Iowa Highway Commission. He is a professional engineer licensed in New York, Iowa, and Oregon.

Long active in the ASCE Construction Division, he has served it as program committee chairman and secretary. While in Portland, Ore., from 1951 to 1953 as resident engineer for Frederic R. Harris, Inc., of New York, he started and edited the *Oregon Civil Engineer*, publication of the Oregon Section of ASCE.

W. E. Jessup is editor of *Civil Engineering*. R. K. Lockwood, heretofore executive editor, has been promoted to assistant to the executive secretary of ASCE. W. H. Wisely is executive secretary.

## Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until July 26. Duplicate double-spaced typwritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before July 26.

**57-217 Turbine-Generator Rotor Prewarming.** *W. J. Gilson, Jr., M. Temoshok*

**57-474 Two-Reaction Theory of a General Induction Machine and Its Equivalent Circuit.** *Y. H. Ku, D. W. C. Shen*

**57-486 Induced High-Frequency Currents in Squirrel-Cage Windings.** *P. L. Alger*

**57-498 A High-Power-Factor One-Running-Capacitor 2-Motor System.** *S. S. L. Chang*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

## 1957 Nuclear Congress Papers Are Now Available

The papers in the following list are available in separate copy form until January 15, 1958. Nuclear Engineering and Science Conference (NESC) papers are priced at 30¢ each. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the American Society of Mechanical Engineers (ASME) Order Department, 29 W. 39th St., New York 18, N. Y.

**Coolants**

57-NESC-76 Gas Coolant for Nuclear Reactors. *Michael Silverberg*

57-NESC-80 Use of Boiling Water as a Reactor Coolant. *S. Untermeyer*

57-NESC-104 $UO_2$—Nak Slurry Studied in Loops at 600 C. *H. E. Flotow, R. D. Carlson, B. M. Abraham*

57-NESC-113 Heat Transfer Considerations in the Use of Organic Reactor Coolants. *T. T. Shimazaki, W. F. Anderson*

57-NESC-115 Design and Development of the Coolant System for the Sodium Reactor Experiment. *D. T. Eggen, A. M. Stelle, M. Heisler*

**Educational Use of Reactors**

57-NESC-73 Educational Uses of the Small 5-Watt Laboratory Reactor. *J. W. Flora*

57-NESC-74 Reactor Experiments in ORSORT. *Herbert Pomerance*

57-NESC-75 The Argonaut Reactor. *R. H. Armstrong, G. N. Kelber, D. H. Lennox, B. I. Spinrad*

57-NESC-85 The Water Boiler as an Instructional Tool. *C. K. Beck*

57-NESC-105 Educational Uses of the Pickle-Barrel. *Richard Stephenson*

57-NESC-110 A Portable, Polyethylene-Moderated, Training and Research Reactor (The *AGN 201*). *A. T. Biehl, R. A. Fayram, M. Harvey, G. A. Linenberger, J. D. Randall, M. C. Reder*

57-NESC-112 The Thermal Test Reactor and Its Applications. *H. B. Stewart, G. B. Gavin, R. E. Slovacek*

**Fuel-Cycle, Economics, Production, and Recovery**

57-NESC-22 Reactor Design and the Fuel Cycle. *R. B. Spooner*

57-NESC-23 Conceptual Design of Remote Fabrication Plant. *Joseph Koslov, C. M. Ladd*

57-NESC-26 Conceptual Design of Pyrometallurgical Reprocessing Plant. *Louis Basel, Joseph Koslov*

57-NESC-27 Liquid Metal Fuel Reactor (LMFR). *C. J. Raseman, H. Susskind, C. H. Waide*

57-NESC-41 Fuel Cycles in Single-Region Thermal Reactors. *Manson Benedict, T. H. Pigford*

57-NESC-42 The Fuel Cycle from the Standpoint of the Fuel Reprocessor. *C. E. Stevenson*

57-NESC-45 Pilot-Plant Studies on Nonaqueous Leaching of Western Ores. *D. D. Foley, W. A. Meeley, R. B. Filbert, Jr.*

57-NESC-46 Uranium Recovery at the Oak Ridge Gaseous Diffusion Plant. *R. J. Clouse, J. Dykstra, B. H. Thompson*

57-NESC-47 The Uranyl Ammonium Phosphate Process for Recovery of Uranium $MgF_2$ Slag Scrap. *E. R. Johnson, E. O. Rutenkroger, A. B. Kreuzmann, B. C. Doumas*

57-NESC-48 Refining of Uranium Ore Concentrates. *D. S. Arnold, B. G. Ryle*

57-NESC-49 Methods for the Production of Thorium Metal. *O. C. Dean*

57-NESC-52 The Economic Background for the Competitive Development of Nuclear Power. *H. W. Nelson, W. R. Keagy, Jr.*

57-NESC-55 Magnesium Extraction Process for Plutonium Separation from Uranium. *I. O. Winsch, Leslie Burris, Jr.*

57-NESC-56 Decontamination of Irradiated Uranium by a Fluoride Volatility Process. *W. J. Mecham, R. C. Liimatainen, R. W. Kessie, W. B. Seefeldt*

57-NESC-57 Nuclear Safety Considerations in Reactor Fuels Processing Plant Design. *Norman Ketzlach*

57-NESC-58 Comments on Waste Disposal at Hanford. *R. E. Burns, M. J. Steidwell*

57-NESC-59 New Developments in Head-End Methods for Preparation of Fuels for Aqueous Processing. *R. E. Blanco, J. E. Savolainen*

57-NESC-67 Reactor Complex Interdependence Resulting from Fuel Recycle. *S. Lawroski, W. A. Rodger*

57-NESC-68 Preparation and Properties of Aqueous Thorium-Uranium Oxide Slurries. *J. P. McBride, V. D. Allred, C. E. Schilling, E. F. Jones*

57-NESC-91 The Use of a Fluidized Bed Process for the Production of Green Salt ($UF_4$). *N. Levitz, E. J. Petkus, H. M. Katz, A. A. Jonke*

57-NESC-93 Decay and Storage of Irradiated Fuel. *J. W. Ullman, E. D. Arnold*

57-NESC-100 An Ion Exchange Process for the Recovery of Plutonium from Irradiated Fuels. *A. M. Aikin*

57-NESC-101 Economics of Ceramic Fuel Elements for Nuclear Power Reactors. *J. R. Johnson*

57-NESC-102 Fuel Processing and Recycling for Natural Uranium Power Reactors. *H. K. Rae*

57-NESC-118 Nuclear Waste Economics—State of the Art. *E. I. Goodman*

57-NESC-120 Hard-End Steps in Preparation of Fuels for Aqueous Processing. *J. A. Buckham*

57-NESC-122 Electrolytic Recycle Method for Treatment of Radioactive Nitric Acid Waste. *H. W. Alter, D. L. Barney, A. C. Schafer, F. J. Witt*

57-NESC-123 Fuel Handling System for a Fast Breeder Reactor. *J. E. Seward, G. R. Nash*

**Heat Transfer and Heat Evolution**

57-NESC-2 Electrical Problems in Electrical Burnout Testing of Nuclear Fuel Elements. *T. W. Hunt*

57-NESC-29 The Integral Spectrum Method for Gamma Heating Calculations in Nuclear Reactors. *L. G. Alexander*

57-NESC-30 Nusselt Values for Estimating Turbulent Liquid Metal Heat Transfer in Noncircular Ducts. *J. P. Hartnett, T. F. Irvine, Jr.*

57-NESC-64 Natural Convection Inside a Horizontal Cylinder. *W. R. Martini, S. W. Churchill*

57-NESC-78 The Time and Temperature Dependence of Thermal Stresses in Cylindrical Reactor Fuel Elements. *K. R. Merckx*

57-NESC-81 Transient Thermodynamics of Reactors and Process Apparatus. *D. H. Brown*

57-NESC-119 Mechanical and Thermal Problems of Water Cooled Nuclear Power Reactors. *N. J. Palladino, J. Sherman*

**Instrumentation**

57-NESC-19 The Development of a Universal Type Control Drive Mechanism for Nuclear Reactors. *Gilbert Rolan, Charles Hinrichs*

57-NESC-25 Dynamic Simulation of a Fast Reactor System. *R. G. Olson*

57-NESC-34 Health Physics Instrumentation for a Power Reactor. *G. H. Whipple*

57-NESC-35 Solid-State Neutron-Flux Measuring System. *T. S. Gray, W. M. Grim, Jr., F. S. Replogle, R. H. Spencer*

57-NESC-36 Acoustic Ionization Detector. *D. R. Whitehouse, F. S. Replogle, Jr.*

57-NESC-37 Millimicrosecond Coincidence System. *J. G. Lundholm, Jr., J. A. Bjorkland, A. C. Menius, Jr.*

57-NESC-38 Safety Circuit Development at Brookhaven National Laboratory. *J. E. Binns, W. Lones, D. G. Pitcher, M. Melice*

57-NESC-39 The Development of a Thermal-Neutron-Flux-Measuring Instrument. *C. V. Weaver, C. K. Smith, J. W. Chastain*

57-NESC-40 A Wire-Activation Technique for Reactor-Flux-Profile Measurements. *A. E. Klickman, F. R. DeFalco*

57-NESC-50 Radiation Flux Conditions in Radioactive Media with Applications to Radiation Monitoring. *B. E. Dahlin*

57-NESC-60 The Logarithmic-Diode Counting-Rate Meter and Period Meter. *B. B. Barrow*

57-NESC-61 Evolution of Neutron Sensing Elements—Scientific Laboratory to Industrial Application. *L. E. Johnson*

57-NESC-70 Recent Developments in Nuclear Instrumentation at the Knolls Atomic Power Laboratory. *R. S. Stone*

57-NESC-77 Control Problems in Sodium Cooled Graphite Moderated Reactors. *J. E. Owens*

57-NESC-83 A Resistance-Temperature Detector for Nuclear Reactor Service. *F. R. Sias*

57-NESC-84 Ultrasonic Flowmeter Monitors Reactor Heat Exchange Circulation. *M. Koblenz, R. Spiegel, S. Kass, H. Sterling*

**Merchant Ship Safety**

57-NESC-11 Development of Safety Standards for Nuclear Propulsion of Merchant Ships. *C. P. Murphy A. R. Gatewood*

**Metallurgy and Radiation Effects**

57-NESC-3 The Corrosion Properties of Zirconium-Base Fuel Alloys. *S. Kass*

57-NESC-4 The Corrosion of Uranium-Molybdenum Alloys in High-Temperature Water. *M. W. Burkart, I. Cohen, R. K. McGeary*

57-NESC-5 Uranium-Columbium Alloy Diagram. *B. A. Rogers, D. F. Atkins, E. J. Manthos, M. E. Kirkpatrick*

57-NESC-6 Internal Friction and Shear Modulus of Thorium at High Temperatures. *C. E. Dixon, H. Hori*

57-NESC-7 Self-Diffusion in Thorium. *C. J. Meechan*

57-NESC-8 The Effect of Cooling Rate on the Nucleation and Growth of Beta-Uranium Hydride in Metallic Uranium. *H. R. Gardner, J. W. Riches*

57-NESC-9 Effect of Cold Work on the Mechanical Properties of Zircaloy—2. *F. Forscher*

57-NESC-10 Continuous Cooling Transformation Studies for the U-10 wt% Nb Alloy. *S. J. Parry, R. J. Van Thyne, D. J. McPherson*

57-NESC-12 The Metastable Gamma Phase in Uranium Base Molybdenum Alloys. *W. A. Bostrom, E. K. Halteman*

Low Molybdenum Alloys as Potential High-Temperature Reactor Fuels. *F. E. Bowman*

57-NESC-13 The Effect of Irradiation on the Tensile Properties of Uranium. *R. E. Hueschen, R. S. Kemper, W. S. Kelly*

57-NESC-14 Effects of Alloying Element Additions of Molybdenum, Silicon, Aluminium, Titanium, Vanadium, and Niobium on the Thermal Cycling Stability of Uranium. *S. T. Zegler, H. H. Chiswik*

57-NESC-15 Metallographic Studies of Neutron Irradiated Nonfissionable Metals. *C. A. Bruch, E. McHugh, L. J. Doig*

57-NESC-16 Transformation Kinetics and Mechanical Properties of 0.5 and 1.0 w/o Molybdenum-Uranium Alloys. *E. G. Zukas*

57-NESC-20 The Effect of Oxygen on Zirconium-Uranium Epsilon-Phase Alloys. *H. A. Saller, F. A. Rough, A. A. Bauer*

57-NESC-63 Effect of Grain Size on the Growth of Alpha-Uranium under Irradiation. *R. Resnick, L. Seigle*

57-NESC-65 Effects of Irradiation on Power Compacts of Uranium and Some Uranium-Base Alloys. *J. H. Kittel, S. H. Paine*

57-NESC-109 Radiation Stability Studies on Binary Uranium Alloys. *G. D. Calkins, J. E. Gates, A. A. Bauer, F. A. Rough*

## Denver Section Past Chairmen

**PAST CHAIRMEN of the AIEE Denver Section attening a recent meeting in their honor were: (back row, *left to right*) F. A. Eastom, University of Colorado; H. B. Palmer, University of Colorado; H. A. Morgan, Westinghouse Electric Corporation; C. W. Keller, General Electric Company; A. S. Anderson, General Electric Company; (*front row, left to right*) L. A. Stenger, Great Wester Sugar Co., retired; E. R. Jones, The Mountain States Telephone & Telegraph Company; L. A. Robertson, The Public Service Co. of Colorado; and A. E. Paige, Denver University.**

**Natural Resources**

57-NESC-28 Uranium West of the Colorado Plateau. *D. L. Davis, B. J. Sharp*

57-NESC-31 Exploration, Resources, and Production of Uranium. *R. D. Nininger*

57-NESC-32 Zirconium: Mineralogy and Geochemistry. *Clifford Frondel*

57-NESC-43 Recent Redistribution in the Cameron, Arizona Deposits. *S. R. Austin*

57-NESC-44 Patterns of Disequilibrium in Radioactive Ores. *J. N. Rosholt*

57-NESC-69 Environment of Some Wyoming Uranium Deposits. *E. W. Grutt, Jr.*

57-NESC-71 Crystal Chemistry of Carnotite. *P. B. Barton, Jr., D. E. Appleman*

57-NESC-121 Geochemistry of "Sandstone Type" Uranium Deposits. *R. M. Garrels*

**Plant Components**

57-NESC-33 On the Quality Requirements for Steel Valves for Nuclear Power Plants. *J. J. Kanter*

57-NESC-94 5,000 GPM Electromagnetic and Mechanical Pumps for the ERB-II Sodium System. *O. S. Seim, R. A. Jaross*

57-NESC-95 Basic Equations for Predicting Performance of a Nuclear Power Plant Pressurizer. *T. H. Glasser*

57-NESC-97 60-Cycle Induction Heating of Sodium Systems. *R. A. Jaross*

57-NESC-98 Pumps for Nuclear Power Plants. *A. F. Erwin*

57-NESC-103 Pressure Piping as Related to Nuclear Applications. *D. B. Rossheim, J. J. Murphy, C. R. Soderberg, Jr., H. S. Blumberg*

57-NESC-108 Applicability of Clad Steels to Heavy Wall Piping. *J. H. Proctor*

**Plant Containment Concepts and Design**

57-NESC-82 Power Reactor Containment Vessels. *A. J. Raymo*

57-NESC-90 Containment for the EBWR. *A. H. Heineman, L. W. Fromm, Jr.*

57-NESC-116 Design Considerations for an Atomic Power Reactor Containment Structure. *W. C. Siler, L. P. Zick*

**Protection of Water Supplies**

57-NESC-21 Stream Surveys for Radioactive Waste Control. *E. C. Tsivoglou, E. D. Harward, W. M. Ingram*

57-NESC-87 Radioactive Tracers in the Field of Sanitary Engineering. *C. P. Straub, G. R. Hagee*

57-NESC-88 Radiochemical Procedures for the Identification of the More Hazardous Nuclides. *Bernd Kahn, A. S. Goldin*

**Radiation Processing**

57-NESC-86 A Megacurie Cobalt-60 Food Irradiator. *Bernard Manowitz, O. A. Kuhl, Leonard Galanter*

57-NESC-99 The Nuclear Reactor as an Instrument of Medical Research and Therapy. *E. Stickley, J. S. Robertson, L. E. Farr*

57-NESC-114 Use of Ionizing Radiations in Control of Parasitic Infections. *J. Villella, H. J. Gomberg, S. E. Gould*

57-NESC-117 Basic Concepts in the Application of Ionizing Radiations to Foods for Preservation. *B. H. Morgan, G. E. Danald, G. E. Tripp, D. F. Farkas*

**Reactor Design, Operation, and Maintenance**

57-NESC-24 Some Operational Problems of the Nuclear Power Plant. *A. R. Jones, R. L. Witzke*

57-NESC-62 The Homogeneous Reactor Test Mockup. *Irving Spiewak, H. L. Falkenberry*

57-NESC-66 Absorber Materials for Reactor Control. *W. K. Anderson, D. N. Dunning*

57-NESC-79 Nuclear Powered Gas Turbines for Light Weight Power Plants. *F. G. Hammitt, H. A. Ohlgren*

57-NESC-96 EBR-II. Control System. *Ernest Hutter*

# Fall General Meeting Committee

**PLANS ARE WELL UNDER WAY for the 1957 AIEE Fall General Meeting to be held in Chicago, Ill., October 7-11. The General Committee and committee chairmen for the meeting are (seated, *left to right*) D. H. Beal, hospitality; M. J. O'Laughlin, fall frolics; E. H. Finch, general vice-chairman; G. L. Welch, general chairman; Mrs. F. W. McCloska, ladies activities; F. E. Andrews, sale of papers; (*standing, left to right*) F. M. Scott, registration; C. A. Hatstat, technical program and monitors; C. E. Pigue, finance and budget; D. J. Ryan, hotel arrangements; M. J. Adams, general treasurer; F. A. Larson, general secretary; L. E. Randall, trips and transportation; D. W. Gilman, entertainment; and J. E. Smith, publicity. D. K. Chinlund, general session chairman, was not present at the committee meeting.**

# AIEE Members Tour Maytag Plant

**MORE THAN 25 ENGINEERS, members of the AIEE, recently toured the Maytag Company's automatic washer and dryer plant in Newton, Iowa. The engineers, from seven midwestern states, were in Des Moines to attend the AIEE Great Lakes District Meeting. Shown with members of the Maytag engineering staff during their tour of manufacturing facilities at Maytag are (*left to right*) Lloyd Sievers, Altoona, Iowa Power & Light Company; Wilbur Martin, senior electrical engineer at Maytag; E. L. Lacker, West Des Moines, Iowa Power & Light Company; and Neil Newkirk, Maytag design engineer.**

57-NESC-106 Engineering and Construction of the Engineering Test Reactor. *P. D. Bush*

57-NESC-111 Stress-Corrosion Cracking Problems in the Homogeneous Reactor Test. *E. G. Bohlman, George Adamson*

**Shielding, Structural Protection, and Control of Fission Products**

57-NESC-17 The Application of Radioisotopes to the Measurement of Soil Moisture Content and Density. *P. F. Carlton*

57-NESC-18 Structural Features of the Waste Disposal System of the Shippingport Atomic Power Station, Shippingport, Pa. *H. T. Evans*

57-NESC-51 Materials of Biological Shielding. *H. M. Glen*

57-NESC-107 Control of Radioactive Material at the Pressurized Water Reactor. *J. R. Lapointe, R. D. Brown*

**Waste Disposal**

57-NESC-1 Atomic Waste Disposal by Injection into Aquifers. *E. Roedder*

57-NESC-53 Separation of Cesium and Strontium from Calcined Metal Oxides as a Process in Disposal of High Level Wastes. *A. Abriss, J. J. Reilly, E. J. Tuthill*

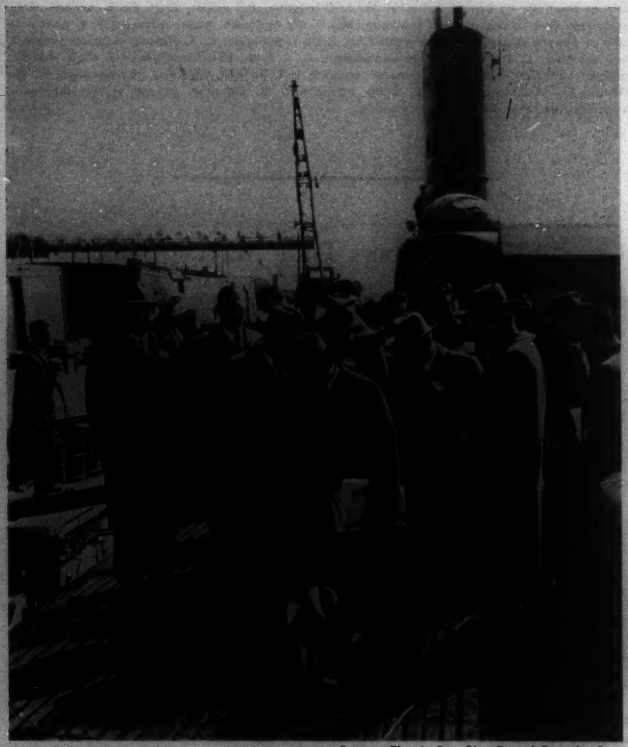
57 NESC-54 Disposal of Fission Products in Glass. *R. W. Durham*

57-NESC-92 Problems Facing State Agencies in Handling Treatment and Disposal of Radioactive Wastes. *E. C. Jensen, E. F. Eldridge, C. M. Everts, Jr., H. C. Clare*

Complete transcripts of the entire Atomic Energy in Industry Conference are available at $15 each from the Director, Conference Division, National Industrial Conference Board, 460 Park Ave., New York 22, N. Y.

Bound sets of the papers presented at the Hot Laboratories and Equipment Conference may be purchased at $10 each from ASME Order Department, 29 W. 39th St., New York 18, N. Y.

## New York Section Inspection Trip



*Courtesy Electric Boat Div., General Dynamics Corp.*

**MEMBERS of the New York Section of AIEE tour a submarine, the U.S.S. Croaker, during an all-day inspection trip to the Electric Boat Division, General Dynamics Corporation, Groton, Conn., on March 21, 1957. The trip was sponsored by the New York Section Power and Industrial Division.**

# COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

### General Applications Division

**Locomotive Motor and Generator Insulation Resistance Testing Subcommittee** (William Schneider, *Chairman*). The purpose and scope of this Subcommittee as conceived by the Land Transportation Committee is to study the known literature, knowledge, and experience of motor and generator insulation resistance or dielectric strength on machines in service for the purpose of better evaluating the life expectancy and possible need for maintenance. It is the recommendation of this Subcommittee that the scope be further refined to cover all phases of testing of rotating electric apparatus on cars and locomotives at periodical inspection intervals to check the adequacy of the winding for further service, and to evaluate its condition in terms of short time operation or long time service, as may be required, depending on the type of inspection and the inspection schedule for future tests.

Basically there are three main categories of locomotive inspections and tests, each of which serves a specific function and requires a different approach to the tests to be performed and the data needed for evaluation. These three test categories can be listed as follows:

1. *Terminal Tests*—This test is performed at relatively short intervals of time when the locomotive is inspected and given a general check-up. At this time, the primary purpose of the test is to check the adequacy of the winding for further short time service and to gain assurance that no failures will occur during the interval of time while the locomotive is in service.

2. *The Overhaul Test*—This test is performed when the locomotive is brought into the shop for a general overhaul and reconditioning. At this time, all of the electrical apparatus must be thoroughly checked and tested, not only to evaluate its condition, but also to predict the life expectancy of the apparatus.

3. *Motor Repair Shop Tests*—When the rotating electric equipment is removed from the locomotive for a very complete check-up and reconditioning, the tests performed by the repair shop must lend themselves to careful analysis and must be accurate in evaluating the condition of the windings and predicting its life expectancy.

It is the recommendation of this Committee that a thorough study be made of the test requirements and an analysis of test data for each of the aforementioned categories. The Committee feels that this approach represents a logical procedure in the establishment of test standards for railway rotating electrical apparatus.

**Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.**

## Industry Division

**Industrial Power Systems Committee** (R. H. Whaley, *Chairman;* R. T. Woodruff, *Vice-Chairman;* H. H. Angel, *Secretary*). Through the efforts of the Electric Power Distribution for Industrial Plants Subcommittee, the second edition of the Red Book has been published. This AIEE publication, *No. 952* entitled "Electric Power Distribution for Industrial Plants," consists of 172 pages of information for electrical engineers who are designing electrical distribution systems for industrial plants. The purpose of this publication is to assist engineers, owners, and plant management to achieve a satisfactory performance of utilization equipment and the efficient operation within the facilities. Since this is only a recommendation, it will stimulate the thinking of engineers who are confronted with the problems associated with the ever expanding use of electrical energy in industrial operation.

The Green Book, AIEE publication *No. 953* entitled "Grounding of Industrial Power Systems," is a companion publication to the Red Book. It was prepared by the Industrial Grounding Subcommittee of the Industrial Power Systems Committee. The general subject of the book includes problems of system grounding, equipment grounding, problems of static, and the problem of obtaining a low resistance connection to the earth.

A third publication will be called the Gray Book and will relate to the work of electrical distribution in commercial buildings. The Distribution Systems for Commercial Buildings Subcommittee and many outside members of the AIEE are pooling their efforts toward the completion of this book which will serve as a guide to engineers who find themselves confronted with many electrical problems in designing for commercial buildings.

The Codes and Standards Subcommittee is developing a fourth companion publication which will be a standard guide for the nomenclature on various types of electrical distribution systems in industry.

## Instrumentation Division

**Electronic and High Frequency Instruments Committee** (Ferdinand Hamburger, Jr., *Chairman;* J. W. Kearney, *Vice-Chairman;* W. C. Gore, *Secretary*). The conversion of the Committee on Instruments and Measurements to Division status and the subsequent smooth transition of the work on Electronic and High Frequency Instruments to that of Committee stature within this Division was undoubtedly due to the previous, autonomous operation of the Subcommittees within the former Committee on Instruments and Measurements as reported last year. The Electronic and High Frequency Instruments Committee opened its first meeting, held during October 1956, with a review of its scope and a note that the instruments themselves were to be given emphasis along with the techniques of using them for making measurements.

The short official history of the Electronic and High Frequency Instruments Committee necessitates commenting on work in progress rather than results obtained. One of the projects under discussion by this Committee is a systematic classification of instruments and test equipment as used in electronic research and development laboratories and the ultimate establishment of uniform specifications for them. Work is in progress to establish standards for d-c amplifiers, regulated power supplies, and counters. The Committee is also cosponsoring a technical session on Instrumentation at the National Electronics Conference in October of 1957.

## Power Division

**Transformers Committee** (J. R. Meador, *Chairman;* D. L. Levine, *Vice-Chairman;* C. W. Miller, *Secretary*). A Committee meeting was held March 28, 1957, in Cleveland, Ohio.

A proposed Power Factor Test Code for Mineral Oil Insulated Instrument Transformers is nearing completion.

Substantial progress has been made by the Working Group on Adequacy of Present Tests on Bushings.

A final draft of the revision of the Loading Guides will soon be circulated for approval. A Loading Guide for Dry-Type Transformers is being prepared.

The Proposed Test Procedure for Thermal Evaluation of Ventilated Dry-Type Power and Distribution Transformers has been published for trial use as AIEE No. 65. Work is continuing on the development of a test procedure for oil-immersed transformers.

In co-operation with other industry groups, proposals for Furnace Transformer Standards have been prepared. Activity was reported on proposed revision of Standards or Test Codes by the Working Groups on Power and Distribution Transformers, Regulators, Rectifier Transformers, Constant Current Transformers, and Instrument Transformers.

The final draft of the Proposed Guide for Maintenance of Transformer Askarel will soon be ready for approval.

Numerous technical investigations are being carried on relating to transformer audible sound measurements, effects of external walls, etc.

A Working Group has approved the use of the Impedance Bridge Method as an alternate standard for measurement of excitation loss and load loss but further work is required before a specific proposal will be made.

The West Coast Subcommittee continues its active interest in all of the varied projects of the other Subcommittees.

# AIEE FELLOWS ELECTED

### Board of Directors Meeting, April 5, 1957

**George Washington Baughman** (M '45), vice-president, Union Switch & Signal, Division of Westinghouse Air Brake Company, Swissvale, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the design and application of railway signaling control systems." Mr. Baughman was born in Gilboa, Ohio, February 11, 1900. He was graduated from Ohio State University in 1920 with a B.S. degree in E.E. He received the professional electrical engineering degree from the same school in 1924. Mr. Baughman joined the engineering department of Union Switch & Signal Company in 1923. For two years prior to that time, he was a research engineer with the Western Electric Company. He was engaged mainly in the field and in development work with Union until July 1944, at which time he was appointed assistant chief engineer in charge of electronics. In March 1945, he was appointed chief engineer. Mr. Baughman was made assistant vice-president in charge of railway signal engineering of Union Switch & Signal on January 1, 1950, and a vice-president of the Westinghouse Air Brake Company in 1951 when the corporate structure of Union was changed to that of a division of the Westinghouse Air Brake Company. Mr. Baughman has been issued nearly 90 patents in the railway signaling field. He is a registered professional engineer in Pennsylvania and New York and holds membership in the honor societies at Tau Beta Pi and Sigma Xi. He is a senior member of the Institute of Radio Engineers. Mr. Baughman is the author of a number of technical papers delivered before AIEE meetings and those of other groups such as the Instrument Society of America, the American Society of Mechanical Engineers, and the University of Michigan's Second Michigan Railroad Management Seminar. From 1951 to

G. W. Baughman

1953, he served as a director of the Pittsburgh Section of AIEE. Mr. Baughman has served on the AIEE Committee on Special Communication Applications (1949-51, 1953-56).

**Clifford Anderson Duke** (M '45), chief, Electrical Laboratory and Test Branch, Tennessee Valley Authority, Chattanooga, Tenn., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the organization of a testing laboratory and staff for a large power system." Mr. Duke was born in Nashville, Tenn., February 14, 1900. He received the B.S. degree in E.E. from the University of Kentucky in 1923. After graduation, Mr. Duke entered the General Electric Test Course at Schenectady, N. Y. From January 1925 to October 1926, he was attached to the engineering departments of the St. Louis office and the Schenectady office. Following this, he became field test engineer for the Tennessee Electric Power Company. In 1930, he was made supervisor of the field test work on the Tennessee Electric Power Company system, and in 1931 was put in charge of all electrical testing for the company. In August 1939, he was employed by the Tennessee Valley Authority as chief test engineer. In 1941, the responsibility for the initial testing and acceptance and the periodic, routine, and emergency testing, adjustment, and maintenance of communication facilities required for the operation of the power systems was transferred to his supervision. Mr. Duke has developed a testing organization composed of approximately 280 employees. In order to provide the engineering personnel for this organization, a training program was developed in which young engineering graduates could be trained for field test work in the minimum amount of time to handle the testing of the wide variety of electrical and communication equipment installed on a large electrical utility system. In connection with this training program, four volumes of test manuals were developed covering all phases of the work. Mr. Duke is the author of several technical papers and articles appearing in national magazines. He is a member of the American Society for Testing Materials. He served on the AIEE Committee on Instruments and Measurements (1949-50).

C. A. Duke

John Grotzinger

**John Grotzinger** (AM '24, M '44), manager, Electrical Engineering Division, Goodyear Tire & Rubber Company, Akron, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the technology of power systems and power supplies for a large industry." Mr. Grotzinger was born in Schaffhausen, Switzerland, December 22, 1891. He received the B.S. degree in E.E. from Bienne Technical Institute in 1913. He joined the American Cyanamid Co., Niagara Falls, Ont., Canada, in October 1913. Following this he was employed by Electro-Metals, Ltd., Welland, Ont., Canada; Pacific Electro Metals Co., San Francisco, Calif.; National Aniline & Chemical Co.; and McKinnon & Dash Co. He joined the Goodyear Tire & Rubber Company in 1920 in power plant design. He was appointed to his present position as manager, Electrical Engineering Division, in 1927. Mr. Grotzinger has been responsible for handling power contracts or design and installation of power plants, and selecting and training engineers who have been sent all over the world to supervise the erection of buildings and power lines and the installation of complete distribution systems and electrical machinery. These projects included 15 foreign and 11 domestic manufacturing plants and two synthetic rubber plants. In 1950, Mr. Grotzinger was sent by Goodyear to Brazil, Argentina, Peru, and Colombia to conduct an extensive study of the power situations. During 1954, he was sent to Europe to conduct a similar study. Mr. Grotzinger took a leading part in organizing the Akron Council of Engineering and Scientific Societies and was its first president. He was chairman of the AIEE Akron Section during 1928-29 and later was president of the Akron Toastmasters Club. He is a registered professional engineer in the State of Ohio. Mr. Grotzinger has served on the following AIEE Committees: Industrial Power Applications (1930-34, 1939-47, chairman 1943-45); Technical Program (1943-45); Standards (1943-45, 1948-50); Safety (1943-47); Electric Heating (1947-49); and Edison Medal (1950-55).

*Courtesy Stoffel Studio*

M. M. Koch

**Marshall McKinley Koch** (AM '20, M '26), vice-president, electrical operations, Public Service Company of Colorado, Denver, Colo., has been transferred to the grade of Fellow in the AIEE ". . . for administrative achievements in directing the engineering, construction and operation activities of a rapidly expanding electric utility system." Mr. Koch was born in Pottsville, Pa., September 24, 1891. He received the B.S. degree in M.E. from Cornell University in 1913 and the M.M.E. degree in 1914 after having been awarded the Edgar J. Meyer Memorial Fellowship in Engineering Research. From July 1914 to January 1916, Mr. Koch was assigned to the cadet engineer program of the Cities Service Company at the Denver Gas and Electric Light Company. Following this, he was a power plant design engineer for Henry L. Doherty and Company, New York, N. Y. He interrupted his career from May 1918 to December 1918 to serve in the U. S. Army after which he returned to Henry L. Doherty and Company as a traveling distribution engineer. In July 1921, he returned to the Denver Gas and Electric Light Company to take over the supervision of engineering, construction, and operation of the electric distribution system. When Public Service Company of Colorado was formed in 1923 to take over the Denver Gas and Electric Light Company and others in Colorado, Mr. Koch became superintendent of electric distribution for the enlarged company. In 1947, he was elected vice-president in charge of electric operations. In this position, he has been in charge of an expansion program which has tripled the company's generating facilities in 10 years, with commensurate increases in all phases of electric operations. Mr. Koch has been active in the affairs of the Rocky Mountain Nuclear Power Study Group of which the Public Service Company of Colorado is a member. He has been a member of the company's board of directors since 1948. He is a past president of the Rocky Mountain Electrical League and is a member of the Advisory Board of the Denver Research Institute. Mr. Koch is a member of Tau Beta Pi and is a registered professional engineer in the State of Colorado.

**Carlisle K. Milner** (AM '37, M '46), vice-president, The Ohio Bell Telephone Company, Cleveland, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to executive and technological leadership of a communication enterprise." Mr. Milner was born in Butte, Mont., August 1, 1900. He received the B.S. degree in M.E. from the University of Colorado in 1922. After graduation, Mr. Milner entered the employ of the Western Electric Company in the New York, N. Y., engineering department. In 1925, this organization became the Bell Telephone Laboratories, Inc. In 1926, he entered the engineering department of the Mountain States

C. K. Milner

H. L. Rorden

C. L. Sampson

R. B. Shipley

Telephone Company where he was engaged in maintenance and circuit work. In 1930, he transferred to Bell Telephone Laboratories, Inc., where he became a member of the technical staff of the laboratories. After spending approximately one year in the inspection engineering department in New York, he was transferred to Cleveland where he served as resident field engineer in the State of Ohio. In 1937, he was transferred to The Ohio Bell Telephone Company where he became maintenance and circuit engineer. He was appointed war activities engineer in 1943; superintendent of construction, engineering, and toll in 1944; and general plant manager in 1945. In 1950, he was made chief engineer. In this capacity he was responsible for the plans and design for all new telephone offices and additions to the existing offices, both local and long distance, as well as the design of all long distance telephone circuits and the engineering methods employed in the design and construction of outside plant. In 1952, he was appointed vice-president of the company, the position he holds at the present time. Mr. Milner is a member of Sigma Tau, Sigma Chi, and the Cleveland Engineering Society. He is a registered professional engineer in the State of Ohio.

**Harold L. Rorden** (AM '30 M '36), high-voltage practice engineer, American Gas and Electric Service Corporation, New York, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to control of lightning and surges of power transmission circuits." Mr. Rorden was born in The Dalles, Oreg., August 27, 1900. He received the A.B. degree from Stanford University in 1925 and the E.E. degree from Stanford in 1926. After graduation, he joined the General Electric Company in Schenectady, N. Y., as a student on the Test Course. He was transferred to the company's Student Engineering Test Course in Erie, Pa., after which he went to Pittsfield, Mass., as junior engineer in high-voltage laboratory development. In 1928, he was made electrical engineer, working in surge generator and high-voltage research, and in 1931 he became engineer, high-voltage research and transformer design. Mr. Rorden joined the Ohio Brass Company, Barberton, Ohio, in 1933 as research engineer, high-voltage development. He remained with this company as development engineer, high-voltage bushing design, until 1942 at which time he was employed by the Bonneville Power Administration in Portland, Ore. There, he was high-voltage engineer responsible for lightning and surge protection on BPA High Voltage Transmission System. In 1954, he joined the American Gas and Electric Service Corporation. Mr. Rorden is the author of many technical papers. He holds 12 patents, including surge generator circuits, protective gaps, high-voltage bushings, flashover indicator, and lightning gap. He is a member of Phi Beta Kappa. Mr. Rorden has served on the following AIEE Committees: Protective Devices (1949-53, 1954-55); and Transmission and Distribution (1954-57).

**Clifford Lawrence Sampson** (AM '25, M '39), vice-president, operations, Northwestern Bell Telephone Company, Omaha, Nebr., has been transferred to the grade of Fellow in the AIEE ". . . for excellent performance in directing engineering, construction, and operations in a large operating communications utility during a period of rapid expansion." Mr. Sampson was born in Minneapolis, Minn., March 31, 1902. He graduated from the University of Minnesota in 1923 with a B.S. degree in E.E. and after about two years of teaching in the electrical engineering department and some graduate study, obtained his M.S. degree in E.E. in 1925. He received the E.E. degree from the same University in 1929. His work with the Northwestern Bell Telephone Company started in 1924 in the plant training course. On a full-time basis after 1925, he became inductive co-ordination engineer in Minneapolis before being transferred to company headquarters in Omaha for the five-state territory of Minnesota, Iowa, the two Dakotas, and Nebraska, to supervise the inductive co-ordination work throughout the territory. In 1928, he was transferred to Iowa in the same capacity, becoming transmission, protection, and foreign wire relations engineer about a year later. Four years later, the duties of plant extension engineer were added. In 1939, Mr. Sampson became Minnesota plant engineer supervising all outside plant engineering. One year later, he was appointed chief engineer in Des Moines for the Iowa area, a position he held except for nine months in Washington, D. C., directly aiding the war effort, until he was transferred to the General Offices in Omaha as assistant vice-president in 1944. In his Washington assignment, he served as special advisor to the War Production Board in 1942. In the Omaha assignment, he supervised and prepared long range planning programs for the company. He served as vice-president and general manager for Iowa from 1946 until 1954 when he was appointed to his present position of vice-president, operations. Mr. Sampson is a member of Sigma Xi and Eta Kappa Nu. He has held various offices in the Iowa Section of AIEE including chairman. He is a member of a committee of the Business and Defense Services Administration of the Department of Commerce and of the Omaha Industrial Foundation.

**Randall Bruce Shipley** (AM '37, M '44), electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn., has been transferred to the grade of Fellow in the AIEE ". . . for originality in the use of mathematical methods for the solution of complex electrical transmission system problems." Mr. Shipley was born in Milligan, Tenn., September 27, 1913. He received the B.S. degree in E.E. from the University of Tennessee in 1936 and the M.S. degree in E.E. from the same University in 1945. After graduation in 1936, Mr. Shipley became relay tester for the Tennessee Public Service Company in Knoxville, Tenn. From 1938 to 1941, he was an engineer for the

## Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus and Systems,* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Knoxville Electric Power Board. Following this, he was electrical engineer for the Tennessee Valley Authority until 1943. He then spent two years as electrical engineer at the Philadelphia, Pa., Navy Yard where he designed electrical control and power system circuits for shipboard installation. In 1945, he returned to the Tennessee Valley Authority as electrical engineer in the Division of Power Operations where he invented a device for automatically testing and plotting distance relay characteristics. Since 1952, he has been in the Division of Power Engineering and Construction working with mathematical analysis of major power transmission system for the purposes of system planning and relay application. He has developed special mathematical techniques, using Tensor Analysis, so that major and previously unsolved power system problems could be solved on digital computers. Mr. Shipley is the author of several technical papers. He is a member of Tau Beta Pi, Phi Kappa Phi, Tennessee Society of Professional Engineers, and the Tensor Club of Great Britain. He is a registered professional engineer in the State of Tennessee.

# AIEE PERSONALITIES

**Ernst Weber** (AM '31, F '34), vice-president for research at the Polytechnic Institute of Brooklyn, has been named a member of the Army Scientific Advisory Panel. In accepting the invitation of Secretary of the Army W. M. Brucker to serve on this panel, Dr. Weber joins a group of the country's leading scientists and educators who advise and counsel the military on scientific and related matters pertaining to national defense. Holder of the Presidential Certificate of Merit, Dr. Weber's service to the United States dates back to World War II when he organized a group of electronics experts who solved critical problems in the then infant art of microwave measurements and standards, sorely needed for assuring the accuracy of radar. In the field of microwave techniques, Dr. Weber holds more than 50 American, British, and Canadian patents. Under his leadership, the Microwave Research Institute at Polytechnic Institute of Brooklyn was created in 1945. He also served as head of the Institute's department of electrical engineering. Dr. Weber relinquished both of these assignments in January of this year to direct Polytechnic's over-all research program. A native of Vienna, Austria, Dr. Weber went to Polytechnic in 1930 as a visiting professor. He is a member of the board and a member of the executive committee of the Institute of Radio Engineers, and a fellow of the American Physical Society. Dr. Weber has served on the following AIEE Committees: Basic Sciences (1935-47); Research (1935-39); Charles LeGeyt Fortescue Fellowship (1942-48); Instruments and Measurements (1950-56, chairman 1955-56); Board of Examiners (1954-57); Science and Electronics Division (1955-57); Education (1956-57); Technical Operations Department (1956-57); Instrumentation Division (1956-57); Indicating and Integrating Instruments (1956-57); Special Instruments and Auxiliary Apparatus (1956-57); Electronic and High-Frequency Instruments (1956-57).

**C. V. Roseberry** (AM '47, M '51), manager of commercial atomic power activities, Westinghouse Electric Corporation, Pittsburgh, Pa., has been elected vice-president and appointed manager of the company's midwestern region with headquarters in Chicago, Ill. Mr. Roseberry is a native of Blackwell, Okla. He received his B.S. degree in E.E. from Oklahoma A. & M. in 1934 and the same year joined Westinghouse on the graduate student training course at East Pittsburgh, Pa. In 1936, he was assigned to the San Francisco, Calif., office of the company as a central station salesman. He was named assistant central station manager for the Pacific Coast district in 1947 and two years later was appointed central station supervisor for the Los Angeles, Calif., area. Mr. Roseberry was assigned to Pittsburgh, Pa., headquarters in January 1951, as manager of electric utility sales. Early in 1955, the electric utility and transportation sales department was formed under his direction. He was named manager of commercial atomic power activities in September 1955, with responsibility for the development, design, and sale of all commercial nuclear reactors. Mr. Roseberry is a member of the American Society of Mechanical Engineers, American Society of Naval Engineers, American Society of Naval Architects and Marine Engineers, and the American Nuclear Society. He is also a member of Eta Kappa Nu.

**Alexander Greenfield** (AM '47), director of research and development, Daystrom Instrument Division, Daystrom, Inc., has been appointed director of research, development, and engineering, Fischer & Porter Co., Hatboro, Pa. After graduating with honors from Pratt Institute with a bachelor's degree in electrical engineering, Mr. Greenfield obtained an M.E.E. degree at New York University, New York, N. Y. Additional graduate work in mathematics and physics was done at Wayne and New York Universities. Prior to his Daystrom affiliation, Mr. Greenfield was in the research department of Bendix Aviation and had been with the Remington-Rand Institute for Advanced Research where he had been responsible for most of the original design for the Univac *120*. During his professional career, Mr. Greenfield has handled research and development projects relating to computers, nuclear instrumentation, telemetering, and guided missiles. Mr. Greenfield is a registered professional engineer in the State of New York. He holds memberships in the Institute of Radio Engineers, American Rocket Society, Association for Computing Machinery, American Ordnance Association, American Management Association, and the National Society of Professional Engineers.

**T. J. Russell** (AM '22), manager, Bridgeport, Conn., sales office, Westinghouse Electric Corporation, has joined the firm of Westcott and Mapes, Incorporated, Architects and Engineers, New Haven, Conn. Mr. Russell was with the Westinghouse Electric Corporation as manager of their Bridgeport sales office for 31 years. Before that he was with the United Illuminating Company of New Haven, Conn., for a number of years. Mr. Russell was on the headquarters engineering staff of the Central Hudson Gas and Electric Company for a time and was also in charge of the electric department at the Boardman Trade School. He is a past president of the Bridgeport Kiwanis Club and the Bridgeport Engineers Club. He has been a representative on the Connecticut Technical Council for a number of years and chairman of the Council for two terms. He is past chairman of the AIEE Connecticut Section and a member of the American Arbitration Association. He served with the Yale Unit in World War I. Mr. Russell is the author of "Personal Efficiency, the Temple Builder" and has given a series of radio broadcasts on salesmanship.

**W. J. Mann, Jr.** (AM '19, M '43), president of The Wolfe & Mann Mfg. Co., Baltimore, Md., has been elected to the position of chairman of the board, with general direction of the company's activities. **W. B. Mann** (AM '40, M '51), treasurer of the company, has been elected president.

**J. S. Quill** (AM '43, M '49), engineer, engineering services operation of the General Electric Company, Schenectady, N. Y., has been appointed manager of marketing research and product planning for the General Electric industry control department, Roanoke, Va. Born in Beverly, Mass., Mr. Quill graduated from Massachusetts Institute of Technology in 1942 with B.S. and M.S. degrees and joined General Electric as a member of the industry control department that same year. Prior to his new appointment, he was assigned to the company's engineering services operation in Schenectady where he was responsible for conducting special engineering studies. He has a strong background in control engineering, having served from 1942 until 1949 as a design engineer in the company's Control Division. In 1952, Mr. Quill received the Coffin Award, General Electric's highest honorary award to an employee, for his outstanding work in the gas turbine field.

**K. S. Geiges** (AM '31, F '51), chief engineer, Underwriters' Laboratories, Inc., Chicago, Ill., has been elected vice-president at the Santa Clara, Calif., office. Mr. Geiges was born in Providence, R. I., in 1908 and graduated from Newark (N. J.) College of Engineering in 1928 with a B.S. degree in E.E. He joined the Underwriters' Laboratories' staff at New York, N. Y., as assistant electrical engineer in 1928. He was appointed associate engineer in New York in 1940 and service engineer in 1941. From 1942 to 1943, he served with the War Production Board in the Conservation Division and from 1943 to 1946 was on active duty as Lieutenant in the U. S. Navy. Upon his return to Underwriters' Laboratories in New York, he was placed in charge of the

electrical department in that office. In 1951, he was appointed chief electrical engineer, and in 1954 was moved to the Laboratories' main office in Chicago, Ill., where he was appointed chief engineer in charge of all engineering departments. Mr. Geiges has served on the following AIEE Committees: Electronics (1947-49) and Metallic Rectifiers (1949-52).

# OBITUARIES

**Bernard E. Beckner** (AM '47), general engineer, electromechanical department, Naval Ordnance Test Station, Pasadena, Calif., died recently. Mr. Beckner was born in Detroit, Mich., July 18, 1922. He attended Michigan College of Mining and Technology, receiving B.S. degrees in E.E. and M.E. in 1946. His experience included working at Detroit Steel Products Company, Chevrolet Central Office, Lee Engineering Company, and as research engineer for the Boeing Aircraft Company, Seattle, Wash.

**Alan Hogarth Burritt** (AM '38, M '56), electrical engineer, Eastman Kodak Company, Rochester, N. Y., died recently at the age of 43. Mr. Burritt was born in Yonkers, N. Y., on January 5, 1914. He was graduated from Rensselaer Polytechnic Institute in 1937 with a B.S. degree in E.E. Since his graduation in 1937, he had been employed by the Eastman Kodak Company of Rochester as an electrical engineer.

**Harold L. Hazeltine** (AM '20, M '26, F '40), vice-president and director, The Sterling Varnish Company, Haysville, Pa., died recently. Mr. Hazeltine was a native of Long Island, N. Y., and a graduate of Yale University, class of 1913. Prior to joining The Sterling Varnish Company in 1920, he was engaged in teaching at Yale University and Georgia Institute of Technology. His first position with the company was as eastern sales engineer. He later became engineer of insulation, vice-president, and director, and served in that capacity until his death. He was instrumental in the development and introduction of many new materials and ideas for the insulation of electric equipment. Mr. Hazeltine was a member of the Yale-Harvard-Princeton Club, and the Yale Club.

**Paul B. Juhnke*** (M '20, F '36, Member for Life), retired chief operating engineer of Commonwealth Edison Company, Chicago, Ill., died October 31, 1956. He was 77 years old. Born in West Prussia in 1879, Mr. Juhnke came to the United States at the age of 12. He was graduated from Lewis Institute in 1903 with the degree of mechanical engineer. He joined the Commonwealth Edison Company in 1903 as an electrician's helper. He was made chief load dispatcher in 1912. He was appointed a member of the Commonwealth Edison Advisory Committee in 1929, assistant chief operating engineer in 1942, and chief operating engineer in 1943. He retired from the company in 1947. Mr. Juhnke served as chairman of the Western Society of Engineers electrical section, as president of Lewis Union and Lewis Institute Alumni Association, and as president of Alexian Brothers Hospital. He was a member of the Union League Club of Chicago. Mr. Juhnke served as a member of the AIEE Board of Directors, 1933-34, and as chairman of the Chicago Section of the AIEE in 1928.

**Carthrae Merrette Laffoon** (AM '24, M '39, F '45), manager, a-c engineering department, Westinghouse Electric Corporation, died recently. Mr. Laffoon was born on a ranch in Kansas in 1888. He attended Central Missouri State Teachers' College and then the University of Missouri, receiving the B.S. degree in E.E. in 1914 and the M.S. degree in 1915. He joined the Westinghouse graduate engineering training course in 1916 and two years later entered the field of design engineering for that firm. He served successively as manager of five Westinghouse design and engineering departments. In 1938, Mr. Laffoon received the Westinghouse Order of Merit and Silver Award Medal for ". . . outstanding achievements in the fields of engineering, management, and design." In 1949, he received the AIEE Lamme Medal for ". . . outstanding contributions to the design of electric machines, particularly large turbine generators and high frequency generators." In 1954, he was presented with a Missouri Honor Award for Distinguished Service in Engineering by the University of Missouri. Mr. Laffoon served on the following AIEE Committees: Electrical Machinery (1934-37, 1938-45, chairman 1938-40); Board of Directors (1942-47); Technical Program (1938-40); Lamme Medal (1942-46); Edison Medal (1943-45); Power Generation (1943-47); Power Transmission and Distribution (1943-44); and Board of Examiners (1945-50).

**Mason Ford Leftwich** (AM '30, M '47), assistant superintendent of the electrical maintenance and construction department of Duke Power Company and vice-president and secretary of Associated Engineering Company of Charlotte, N. C., died recently. Mr. Leftwich was born in Talcott, W. Va., November 28, 1902. He attended the University of North Carolina. Mr. Leftwich first began work for the Southern Power Company (predecessor of Duke Power Company) in June 1918. He became a full-time employee in 1923 and in September 1948 was promoted to the position he held at the time of his death. Mr. Leftwich was a member of the Charlotte Engineers Club. He served on the AIEE Rotating Machinery Committee (1953-55).

**Roland Roger Miner** (AM '30, M '37), partner, Miner & Miner, consulting engineers, Greeley, Colo., died recently. Mr. Miner was born in Burlingame, Kans., November 2, 1903. He received the B.S. degree in E.E. from the University of Kansas in 1930. After graduation, he joined the Kansas Gas & Electric Company, Wichita, Kans., as an electrical engineer. From 1939 to 1944, he was with the White Eagle Division of Socony Vacuum Oil Co., Inc., in Augusta, Kans. In 1946, after service in the U.S. Navy, the partnership of Miner & Miner, consulting engineers was formed. From 1946 to 1948, he served as associate professor of electrical engineering at Colorado A & M College. Mr. Miner organized and served as the first chairman of the Wichita Section of AIEE.

**Thomas C. Young** (AM '48), partner, Anderson-Young Electric Company, Lubbock, Texas, died recently. Mr. Young was born on May 27, 1914. He received the B.S. degree in E.E. from Texas Technological College in 1935. For one year after graduation, he was a student instructor in the electrical engineering department of Texas A & M. Following this, he was employed by The Texas Company in Houston. From June 1939 to March 1940, he was a junior geophysicist for the Humble Oil & Refining Company, after which he was employed by The Carter Oil Co. in Tulsa, Okla. In 1946, he became a partner in the Anderson-Young Electric Company. Mr. Young was serving as chairman of the Panhandle Plains Section of the AIEE at the time of his death.

*Electrical Engineering* regrets that announcement of Mr. Juhnke's death did not appear sooner, as details were received only recently.

# MEMBERSHIP

## Recommended for Transfer

The Board of Examiners at its meeting of May 16, 1957, recommended the following applications for transfer. Any objection to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

### To Grade of Member

Amchin, H. K., electrical engineer, American Gas & Electric Service Corp., New York, N.Y.
Amin, N. B., director, Jyoti Ltd., Baroda, India
Anderson, G. R., Jr., asst. chief engineer, Fairbanks, Morse & Co., Chicago, Ill.
Bailey, R. C., engineer, Ohio Bell Tel. Co., Cleveland, Ohio
Bartz, M. E., field engineer, General Electric Co., Chicago, Ill.
Black, J. G., project design engineer, Eastman Kodak Co., Rochester, N.Y.
Bouchey, S. H., Jr., test engineer, Potomac Electrical Power Co., Washington, D.C.
Boyd, R. A., stations-superintending engineer, Hydro-Quebec Power Commission, Montreal, Que., Canada
Brookes, A. S., senior engineer, Public Service Electric & Gas Co., Newark, N.J.
Brown, H. E., senior engineer, Commonwealth Edison Co., Chicago, Ill.
Brust, H. A., application engineer, General Electric Co., Schenectady, N.Y.
Chenoweth, R. D., assistant professor, Case Institute of Technology, Cleveland, Ohio
Clark, E. W., senior design engineer, Emery Industries, Inc., Cincinnati, Ohio
Cowdery, R. E., supervisory engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.
Cox, D. J., electrical engineer, U. S. Corps of Engineers, Omaha, Nebr.
Craine, L. B., associate electronics engineer, Washington State College, Pullman, Wash.
Crapo, H., manager-product design, Leland Electric Co., Dayton, Ohio
Crapo, W. L., equipment engineer Duquesne Light Co., Pittsburgh, Pa.
Davis, E. T., substation maintenance supervisor, B. C. Power Commission, Nanaimo, B.C., Canada
Doon, H. H., principal engineer, Burns & Roe, Inc., New York, N.Y.
Easley, J. H., application engineer, General Electric Co., Philadelphia, Pa.
Eddy, L. B., engineer, Universal Oil Products Co., Des Plaines, Ill.

Esarey, R. W., manager, aircraft equipment dept., Westinghouse Electric Corp., Lima, Ohio

Evans, W. G., supervisory engineer, Westinghouse Electric Corp., Pittsburgh, Pa.

Fleager, W. M., general traffic engineer, The Pacific Tel. & Tel. Co., San Francisco, Calif.

Fleissner, J. M., relay engineer, Wisconsin Electric Power Co., Milwaukee, Wis.

Fletcher, W. H., engineer, U.S. Bureau of Reclamation, Denver, Colo.

Fowler, R. J., division engineer, Consumers Power Co., Flint, Mich.

Garrett, R. E., senior engineer, Newbery Electric Corp., Los Angeles, Calif.

Gifford, J. H., senior engineer, Westinghouse Electric Corp., Baltimore, Md.

Giordano, A. B., professor of electrical engineering, Polytechnic Institute of Brooklyn, N.Y.

Gordon, M. B., electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn.

Hallenberg, E. X., assistant director, research laboratories, Westinghouse Electric Corp., Pittsburgh, Pa.

Haller, J. T., engineer, commercial atomic power activity, Westinghouse Electric Corp., Pittsburgh, Pa.

Hamilton, H. B., head, electrical engineering dept., University of Wichita, Wichita, Kans.

Hammond, C. E., machinery electrification manager, Westinghouse Electric Corp., San Francisco, Calif.

Harden, C. R., electrical design group leader, Anheuser-Busch, Inc., St. Louis, Mo.

Harvey, E. A., assistant chief engineer, Cemco Electrical Mfg. Co., Vancouver, B.C., Canada

Healy, W. L., specialist, data bureau & library, General Electric Co., Philadelphia, Pa.

Heckman, W. R., assistant manager of operations, The Clark Controller Co., Cleveland, Ohio

Hoffman, H. T., Jr., research engineer, Bailey Meter Co., Cleveland, Ohio

Holland, D. R., relay engineer, Baltimore Gas & Electric Co., Baltimore, Md.

Hood, H. R., senior engineer, Southern Services, Inc., Birmingham, Ala.

Hoss, G. L., aeronautical research engineer, National Advisory Commission for Aeronautics, Cleveland, Ohio

Howland, H. W., application engineer, General Electric Co., Cleveland, Ohio

Hudson, D. M., chief electrician, A. P. Green Fire Brick Co., Mexico, Mo.

Hudson, H. F., senior engineer, Salt River Power District, Phoenix, Ariz.

Hunter, A., Jr., electrical engineer, The Budd Co., Philadelphia, Pa.

Illman, R. W., staff engineer-dynamics, Boeing Airplane Co., Seattle, Wash.

Jesatko, J. M., product engineer, insulator dept., General Electric Co., Baltimore, Md.

Jessen, O. C., electrical engineer, dept. of water & power, Los Angeles, Calif.

Johnson, D. L., professor & head, electrical engineering dept., Louisiana Polytechnic Institute, Ruston, La.

Jones, L. D., electrical engineer, Century Electric Co., St. Louis, Mo.

Kapp, C. G., manager, aircraft motor engineering, Jack & Heintz, Inc., Cleveland, Ohio

Kasmer, C. M., electrical engineer, Vern E. Alden Co., Chicago, Ill.

Kennedy, P. C., assistant chief engineer, Marco Industries, Inc., Womelsdorf, Pa.

Kohl, F., research engineer, Precision Scientific Co., Chicago, Ill.

Laughlin, J. W., electrical designer, Bechtel Corp., San Francisco, Calif.

Lawry, C. C., Jr., manager, inertial equipment unit, General Electric Co., Schenectady, N.Y.

Lazinski, R. H., research project engineer, Fischer & Porter Co., Hatboro, Pa.

Liles, R. B., owner, Robert B. Liles, Architect & Engineer, 340 Pine St., San Francisco, Calif.

Lippert, M. L., electrical engineer, Black & Veatch, Kansas City, Mo.

Maier, R. H., project engineer, Motorola, Inc., Chicago, Ill.

McDonald, J. K., project engineer, Pennsylvania Power & Light Co., Allentown, Pa.

McFarland, V. C., new business manager, Southwestern Gas & Electric Co., Shreveport, La.

McKernon, W. D., electrical engineer, U.S. Naval DPW., San Francisco, Calif.

McRuer, D. T., board chairman, Control Specialists, Inc., Inglewood, Calif.

Meister, J. B., engineer & lawyer, Commonwealth Edison Co., Chicago, Ill.

Mishra, N. D., senior specialist, Bhakra Designs Directorate, New Delhi, India

Moore, L. C., southeastern regional manager, Westinghouse Electric Corp., Atlanta, Ga.

Moyer, D. F., consulting engineer, 94 Patterson Rd., Dayton, Ohio

Nelson, J. A., electrical engineer, Commonwealth Associates, Inc., Jackson, Mich.

Nix, R. P., engineer, Southwestern Gas & Electric Co., Shreveport, La.

Parish, A. R., senior section engineer, English Electric Co., Stafford, England

Parish, W. R., assistant professor, electrical engineering dept., University of Idaho, Moscow, Idaho

Paul, E. A., industrial sales representative, Pennsylvania Power & Light Co., Scranton, Pa.

Paul, J. S., chief engineer, Calcutta Jute Mfg. Co., Ltd., Calcutta, India

Pfaff, W. R., manager, St. Catharines Public Utilities Commission, St. Catharines, Ont., Canada

Pierce, L. R., design engineer, General Electric Co., Richland, Wash.

Purdy, G. L., design engineer, Westinghouse Electric Corp., Lima, Ohio

Ramirez, J. A., senior engineer, Creole Petroleum Corp., Maracaibo, Venezuela, S.A.

Ratcliff, W. L., partner, W. L. Ratcliff Co., Shreveport, La.

Reeves, D. W., president, Public Service Co. of New Mexico, Albuquerque, N.M.

Reuter, J. E., electrical engineer, Vern E. Alden Co., Engineers, Chicago, Ill.

Riggs, J. R., supervisor-technical publications, General Electric Co., Pittsfield, Mass.

Rose, J. E., sales engineer, General Electric Co., Akron, Ohio

St. Pierre, L. C., zone superintendent of power, Commonwealth Edison Co., Wheaton, Ill.

Sauber, R. C., sales engineer, Strong Carlisle & Hammond Div., White Sewing Machine Corp., Toledo, Ohio

Saucerman, G. B., manager, aircraft equipment sales unit, General Electric Co., Los Angeles, Calif.

Schneider, P., supervising engineer, The Ohio Bell Tel. Co., Cleveland, Ohio

Sernel, F. J., electrical engineer, The Clark Controller Co., Cleveland, Ohio

Shirey, E. L., watch electrician, Chicago District, Electric Generating Corp., Hammond, Ind.

Silliman, S. D., engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

Smith, F. B., assistant manager, Scott Paper Co., Mobile, Ala.

Teker, W., project analyst locomotive & car equipment dept., General Electric Co., Erie, Pa.

Tengdin, J. T., sales engineer, General Electric Co., Kansas City, Mo.

Thayer, L. L., senior engineer Michigan Bell Tel. Co., Detroit, Mich.

Theon, A. B., control design engineer, Reliance Electric & Engineering Co., Cleveland, Ohio

Tou, J. T., assistant professor, University of Pennsylvania, Philadelphia, Pa.

Treece, B. G., electrical engineer, Sargent & Lundy, Engineers, Chicago, Ill.

VanBurkleo, G. R., division electrical engineer, Public Service Co. of Oklahoma, Tulsa, Okla.

Vanica, H. R., engineer-radio transmission, Western Electric Co., New York, N.Y.

Vick, H. J., assistant director, Industrial Development Div., Office of Governor, Madison, Wis.

Walsh, J. E., chief load dispatcher, Baltimore Gas & Electric Co., Baltimore, Md.

Weyrick, P. M., design engineer, Westinghouse Electric Corp., Mansfield, Ohio

Wolch, J. H., enginering designer, Boeing Airplane Co., Renton, Wash.

Wolfinger, J. P., Jr., chief electrical engineer, Treadwell Engineering Co., Easton, Pa.

World, R. W., electrical engineer, U.S. Bureau of Reclamation, Denver, Colo.

108 to grade of Member

## Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before July 25, 1957, or September 25, 1957, if the applicant resides outside of the United States, Canada, or Mexico.

### To Grade of Member

Adamson, C., senior lecturer in electrical engineering, Manchester College of Science and Technology, Manchester, England

Barr, W. W., owner, Barr Electric Co., ARLOT, and Associated Research Laboratories of Texas, Dallas, Tex.

Behart, F. A., supervisory engineer, Utilities Operations Div., Military Construction, Office Chief of Engineers, Washington, D.C.

Bolles, L. W., staff engineer, The Pacific Telephone & Telegraph Co., Los Angeles, Calif.

Butler, W. W., associate director, planning, Remington Rand Univac, Division of Sperry Rand Corp., St. Paul, Minn.

Campbell, C. K., staff engineer, Alexander Kusko, Consulting Engineers, Cambridge, Mass.

Catlett, R. L., senior engineer, Philadelphia Electric Co., Philadelphia, Pa.

Curry, G. W., Transportation Specialist, General Electric Co., Dallas, Tex.

Dannemiller, J. R., president, J. R. Dannemiller Associates, Inc., Cleveland, Ohio

Denton, O. L., foreman, Westinghouse Electric Corp., Verona, Va.

DeZoysa, E. W., chief engineer, British Insulated Cannender's Cables Ltd., Colombo, Ceylon

DuBose, J. H., electrical engineer, Tennessee Valley Authority, Chattanooga, Tenn.

Embry, B. L., professor, Utah State University, Logan Utah

Goodman, E. A., electrical engineer, Allis-Chalmers Mfg. Co., Pittsburgh, Pa.

Gosain, G. L., electrical design, Burns and Roe, Inc., New York, N.Y.

Grace, C. H., manager-systems integration, Jack & Heintz, Inc., Cleveland, Ohio

Grossner, N. R., project engineer-unit head, Kearfott Co., Inc., Clifton, N.J.

Guy, R. F., senior staff engineer, National Broadcasting Co., New York, N.Y.

Hagen, J. L., district sales engineer, Louis Allis Co., Appleton, Wis.

Hammar, S. J., associate electrical engineer, Washington Water Power Co., Spokane, Wash.

Healy, R. V., director of physical plant, Phillips Academy, Andover, Mass.

Ingmanson, J. H., vice-president, Whitney Blake Co., executive vice-president, Koiled Kords, Inc., Hamden, Conn.

Kern, H. G., supervisory training officer (Technical Fields), National Security Agency, Washington, D.C.

Long, L. O., design engineer, The Shawinigan Engineering Co. Ltd., Montreal, Que., Canada

Michod, R. N. H., chief electrical engineer, Crompton Parkinson (Australia) Pty. Ltd., Sydney, NSW, Australia

Onnen, D. S., chief engineer of equipment, New Haven Railroad, New Haven, Conn.

Rajesham, N., electrical contractor, Electrical Enterprises Corp. & Kalpana Engineering Co., Hyderabad, Andhra Pradesh, India

Riedel, H. J., staff engineer-European Operations, Worthington Corp., Paris, France

Robertson, J. D., superintendent of dispatching dept., Public Service Company of Oklahoma, Tulsa, Okla.

Seaman, R. P., engineer, Commonwealth Edison Co., Maywood, Ill.

Sisk, J. L., general manager, Nashville Electric Service, Nashville, Tenn.

Stillwater, J., general sales manager, R. M. Ballantyne Co. Ltd. and Cambridge Knitwear Mills Ltd., Stratford, Ont., Canada

Strozier, H. H., assistant chief planning engineer, Georgia Power Company, Atlanta, Ga.

Townsend, G. R., senior design engineer, General Electric Co., Roanoke, Va.

Wermenlinger, D., professor, Laval University, Quebec, Que., Canada

Wilson, H. C., system communication engineer, Central Illinois Public Service Co., Springfield, Ill.

Wolf, A. A., instructor-electrical engineering, University of Pennsylvania, Philadelphia, Pa.

Zetterberg, S. C., president, Aros Electric Inc., New York, N.Y.

58 to grade of member

# ELECTRICAL ENGINEERING EDUCATION

## AIEE in University of Maryland

**THE DEPARTMENT of electrical engineering at the University of Maryland was established in 1908. Prof. L. J. Hodgins, with the assistance of the Washington (D.C.) Section of the Institute, organized the Student Branch of the AIEE on March 9, 1936. Because of increasing interest in the field of electronics and communications, the Joint Student Branch was formed in 1948.**

**The majority of the engineering classes are held in the main engineering building (*right*). This, and other new buildings, made possible through the interest of the Glenn L. Martin Co., were completed in 1950. The increase in facilities allowed an expansion of the work in every department. There are now 1,700 undergraduate engineering students, over one third of this number in electrical engineering. The campus is strategically located between Baltimore and Washington, permitting access to their many outstanding research laboratories.**

**The atmosphere provided by the new buildings and modern equipment combined with stimulating instruction provided by the friendly faculty has produced a rapidly increasing interest in the field of electrical engineering and its associated professional societies.**

# Heinrich Hertz Centennial

BERN DIBNER
FELLOW AIEE

AS WE PAUSE to note the centennial of the birth of Heinrich Hertz, we perceive a classic example of transition of a theory to an analysis and an application of electricity toward human betterment. The theory was advanced by Maxwell, the analysis was supplied by Hertz, and the application to practice was furnished by Marconi. Thus, the work of Hertz formed a bridge from the general principles laid down by the mathematical work of Maxwell to the conquest of space, by signal and picture, made possible by the inventions of Marconi and the many others who were active at the beginning of this century. We shall concern ourselves with Hertz, one of the very great in electrical science.

Heinrich Rudolf Hertz was born in Hamburg, Germany, on February 22, 1857, into a family of scholars and professionals. At first determined to study engineering, he matriculated at the University of Munich in 1877, but after a year felt more strongly drawn to the physical sciences. He mastered the essentials of mathematics and mechanics of Laplace and Lagrange before he moved to Berlin, where he attended the lectures by Kirchhoff and Helmholtz. The problem of electrical inertia in particular was called to his attention through a prize being offered by the University faculty for its solution. This prize was won by Hertz in 1880 for his paper "Kinetic Energy of Electricity in Motion." Encouraged by his success in the winning of this prize, he prepared and offered his doctoral dissertation in the same year with the thesis "Induction in Rotating Spheres" and his doctorate was awarded with the rare distinction of *magna cum laude*. The great Helmholtz who, as early as 1847, already had investigated the oscillatory nature of the discharge from a Leyden jar, engaged Hertz as an assistant in the physics laboratory of the Berlin Institute. The position lasted three years and won for Hertz the special commendation of Helmholtz for work in electrical discharge through gases. It was this investigation that was to prompt Hertz' most important contribution.

To pursue his interest, he went to Kiel and plunged into studies of Maxwell's electromagnetic theory. Although his initial concern with the behavior of electricity in gases (1879) never left him, the studies and discoveries that were to make the name of Hertz immortal were made between 1885 and 1889 while he was professor of physics at the Karlsruhe Polytechnic. Prompted by Helmholtz to relate electromagnetic forces to dielectric polarization of insulators, Hertz tried to formulate a series of experiments to determine their relationship. In May 1884, Hertz entered in his diary: "Hard at Maxwellian electromagnetics in the evening. Nothing but electromagnetics. Hit upon the solution of electromagnetic problem this morning."

Maxwell had established a system of equations that expressed the similarity of polarization and depolarization of an insulator to the electromagnetic effects about a conductor carrying an electric current. In 1864, he had deduced from his mathematical computations that light consisted of transverse waves in the same medium, which was the cause of electric and magnetic phenomena, and that this propagation could occur in free space. He had concluded that electricity, like light, could travel through space by waves, and that magnetic and electric waves complemented one another; these were, therefore, termed electromagnetic waves. The

Bern Dibner is president, Burndy Corporation, Norwalk, Conn.

vibrations generated when a spark surged from a charged conductor created these waves. He had also proposed that if the medium that supported electromagnetic phenomena was also that which supported light *in vacuo*, then their velocities should also be numerically the same as the ratio of electromagnetic and electrostatic units. Between 1837 and 1882, many attempts were made to transmit telegraph signals between two points using electromagnetic induction rather than wires to connect the two points. However, this was effective for only short distances or, as in the case of Hughes, it was demonstrated but not completely understood. It was Hertz who, in 1888, devised the experiments that showed that by electromagnetic waves, and not by induction, signals could traverse substantial distances.

Hertz had reasoned that if he bent a piece of copper wire into the form of a circle or rectangle and left the ends fitted with metal balls and separated by a small air gap, the presence of a potential within the loop might be noted. Such a loop, or resonator, was made (it was about 70 centimeters in diameter), and when it was placed in the discharge field of a spark induction coil, a similar spark was induced in the secondary loop. He interpreted the phenomenon as indicating that the induction and capacity dimensions of the secondary circuit were such as to approximate the electric oscillations in the primary circuit, and that these would, therefore, be greatly intensified by resonance, a subject in acoustics that was much studied by Helmholtz and Hertz. A detector for the propagation of electric waves in free space was thus provided and, with it, the means for confirming Maxwell's theory. By making the distance between the primary and secondary loop beyond that of the range of induction, Hertz proved that this new phenomenon was not a manifestation of induction. In announcing his discovery, he related the new waves to light by adding, "Optics is no longer restricted to minute . . . waves a fraction of a millimeter in length: its field is extended to waves that are measured in decimeters, meters and kilometers."

To radiate the electric waves in free space, Hertz devised an arrangement of two metal spheres or sheets placed in the same plane, each sphere or sheet connected to a terminal of a Ruhmkorff induction coil, with ball electrodes to form a short gap. A modified form of Leyden jar was thus created, one in which the air served as a dielectric between two metal sheets, but having this dielectric extended throughout the air, and therewith insuring maximum radiation energy at each oscillation. Unlike a Leyden jar, the induction coil provided a continuous source of high-frequency oscillations rather than a short-lived single spark. By extending his experiments to transmitting an electric disturbance simultaneously into the air and along a wire. Hertz obtained interference effects and noted the ratio of the velocity of propagation in the air and along the wire. He then determined the

**HEINRICH HERTZ who, in his 36 years of life, demonstrated the radiation principles of electromagnetic waves in space—the basis for radio, radar, and television. This life-size bust was formerly in his family and is now in the Burndy Library.**

velocity to be finite and of the same order as the velocity of light. When the high-frequency oscillators in the circuit and the corresponding resonators were in "tune" with one another, the oscillation frequency reached the order of about 100 million oscillations a second.

Pressing his research, Hertz established the progressive propagation of electromagnetic action in space. He constructed oscillators for producing electric waves and designed equipment for measuring the wavelengths, establishing their nodal points, and varying their length. He also devised circuits that discharged rapidly damped oscillations across an air gap, thereby radiating electromagnetic waves. Resonators placed in the path of the waves detected and signaled their presence. A micrometer added to the resonator gap gave accurate measurements of the intensities of radiation under different conditions and locations.

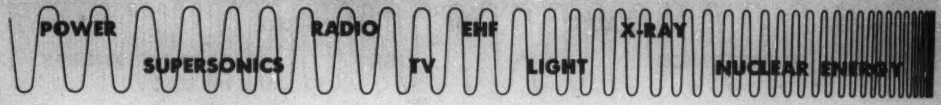
Further, he measured the length and velocity of these electromagnetic waves and established the transverse nature of their vibration. He could reflect and focus the waves by parabolic metal surfaces, refract them with hard pitch prisms (weighing 1,200 pounds), and polarize the waves with parallel wire grids in the same manner as was done with the waves of heat and light. He was able to show that as the length of the waves diminished they approached the characteristics of light waves. The index of refraction of the new waves was determined. Thus the identity of light and electrical vibrations was established experimentally. The announcement of this epochal discovery was made at Heidelberg in September 1889.

The success of this demonstration brought academic honors to Hertz, including the chair of physics at the University of Bonn, to succeed the eminent Clausius. At Bonn, the new professor sought to formulate in simple terms the electromagnetic theory of Maxwell in the light of his recent experiments. He also attempted new experiments in the discharge of electricity in rarefied gases, a field he found rich in tradition at Bonn where Hittorf, Geissler, and Pluecker had worked. Here Hertz discovered that cathode rays could be made to pass through metals, an event that led, through Lenard and Roentgen, to the discovery of X rays.

The demonstrations by Hertz stimulated further investigation by electrical experimenters on both sides of the Atlantic. In America, Edison and Tesla and in England, Lodge and Rutherford, as well as the youthful Marconi, assembled apparatus and probed the behavior of the Hertzian waves.

The apparatus of Marconi, especially an elevated wire and a grounded electrode at the transmission station and an equivalent set at the receiving station, enabled him to extend the range of transmission and reception from the initial few yards at his home in Bologna in 1895. In 1896, this was increased to 400 yards. With improved coherers consisting of fine filings and a little mercury placed in an evacuated tube, the range reached 18 miles two years later, and in 1899 a span of 85 miles was covered. By the end of December 1901, the bridge between the theory of Maxwell and its experimental demonstration by Hertz was dramatically presented to the world by the transmission of the first intelligible radio signal across the Atlantic by Marconi. The earth's curvature did not present an obstacle to the transmission of the Hertzian waves, as it does in the transmission of light.

On New Year's Day, 1894, when Hertz was only 36 years old and at the height of promise to the world of science, he died at Bonn. Thus, like Maxwell who died at 48, passed one of the great figures of




the last century. Where other theorists and experimenters had moved cautiously and with hesitation, Hertz had moved boldly forward. He had gathered a group of related facts and buttressed the new structure with measurements and proofs. The contributions of Hertz have released some of the most cherished gifts of science to our modern civilization. His was the genius that combined the mastery of the theories and mathematical demonstrations of Maxwell and Helmholtz, with an experimenter's skill and exactness. Thus, an error in the determination of the frequency of oscillation of an electric system that came to 5,000 millionths of a second threw him into temporary despondency. Although his methods of attack on a problem were bold and penetrating, his public contacts were modest and retiring. When he was to receive the Rumford Medal of the Royal Society, he quietly disappeared from Bonn for a few days and as silently reappeared to continue his work.

From his laboratory and lecture hall there spread out, like Hertzian waves, new ideas that inspired many other investigators. These invented for us such aids to the spread of intelligence as transatlantic telegraphy (long-wave followed by short-wave), radio broadcasting, and radar for signal interception in aviation, navigation, and meteorology. Further aids in the modern application of Hertzian waves are in long-range telephony, television, and celestial research. Few men have reason to be remembered longer than Heinrich Hertz.

## District No. 6 Announces Student Paper Contest Winners

Several months of reading, writing, and experimenting were brought to a climax on April 29 when 10 papers were presented at the District No. 6 Prize Paper Competition held at the University of Nebraska in Lincoln. All student branches in the District were represented for 100% participation in this important activity.

The winning paper, presented by Charles Parks of the South Dakota School of Mines and Technology, was entitled, "Demonstration Transmission Line." Mr. Parks used a working model to demonstrate standing waves on a line terminated in an open and a short circuit.

The second-place paper, presented by N. A. Shyne, also from the South Dakota School of Mines and Technology, was entitled, "A Transistorized Voltage Regulator." Mr. Shyne utilized the semiconductor devices to advantage in regulating the school's laboratory d-c power supply.

H. A. Schwan placed third with a presentation entitled, "Phonograph Pickup Arm Tangency." Mr. Schwan has constructed a unique servo device for maintaining the pickup arm tangent to the groove in the record at all times. This eliminates side thrust and greatly extends the life expectancy of the record.

## Conference Held on Careers for Girls in Science and Engineering

"Education of Girls for Careers in Science and Engineering" was the subject of the third conference of the Joint Program for Technical Education, April 28-May 1 at Arden House, Harriman, N. Y. The program is sponsored by the School of Engineering of Columbia University and is supported by the Hebrew Technical Institute of New York.

More than 100 delegates, representing elementary and secondary schools in the New York, N. Y., area as well as industry and engineering and liberal arts colleges, attended the four-day conference. They considered ways and means to interest girls and women in careers in engineering and science. The meeting was part of an over-all program designed by the Columbia School of Engineering to help the hard-pressed science departments of the nation's secondary schools. Proceedings of the conference will be published, thus establishing a ready source of information on the subject for use by secondary school educators and guidance counselors throughout the country.

At a dinner on Sunday, April 28, the conference heard an opening address by Dr. Henry David, director of the National Manpower Council and author of the new book entitled "Womanpower." Speakers on Monday included Prof. Esther L. Jones, guidance educator, Teachers College, Columbia University; Mrs. Marguerite Zapoleon, U. S. Department of Labor; Samuel Schenberg, supervisor of science, New York High Schools; and Dr. J. H. Nair of Thomas J. Lipton, Inc. Speakers on Tuesday included Dr. Anne Roe, psychologist, Veterans Administration; Miss Alva Matthews, instructor of civil engineering, Columbia University; and Mrs. Beatrice Hicks of the Society of Women Engineers. The Wednesday morning speaker was Dr. Margaret Mead, anthropologist and Adjunct Professor of Anthropology at Columbia.

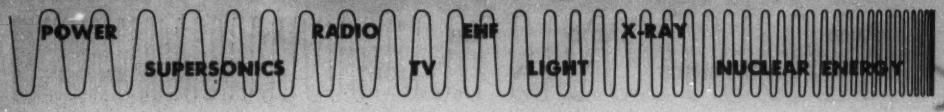
# An Electrical Engineer in Education

**M. G. MALTI (M '45), professor of electrical engineering, Cornell University, Ithaca, N. Y.**

"I have been associated with the AIEE since my student days—an association which has lasted over 35 years. These years have brought both professional and social satisfaction. Professionally, I have contributed my share of technical papers and discussions and have worked on several technical committees. It is work on these committees which is richly rewarding. Here is where one meets engineers of high professional standing. Here is where current contributions to the literature are reviewed and judged, thereby enabling the reviewer to keep up with present day developments in his profession; to develop good technical judgment; and, if he is an educator, to convey his knowledge of current literature to his students. Above all, committee work brings the member into close association with others which invariably results in making friends. The friendships made in the AIEE have enabled me to locate jobs for my students, to find speakers for the local AIEE meetings, and to make proper contact when such contacts were needed by Cornell University. Indeed, every educator should be a member of the AIEE and work on at least one technical committee in his field."

Prof. Malti received the A.B. degree from Beirut University in 1915, the B.S. degree in E.E. from the Georgia School of Technology in 1922, the masters degree in E.E. from Cornell University in 1925, and the Ph.D. from Cornell in 1927. He served as visiting professor at the University of Puerto Rico in 1948 and at present is visiting professor at the University of Roorkee, Roorkee, U. P., India. He has been consulting engineer for several corporations and is a registered professional engineer in the State of New York. Prof. Malti has served as a member and as chairman of several AIEE Committees and Subcommittees.

# Electrical Engineering Education




## AIEE Arizona Section Meets With Student Branch

L. F. Cowden and L. E. Colip, both seniors in electrical engineering at the University of Arizona, were awarded first prize of $100 for a paper presented at a joint meeting of the Arizona Section and the Arizona Student Branch of the AIEE on May 4.

The paper, entitled "Transistor Characteristics Operating in the Reverse Current Mode," was presented by Mr. Cowden at the student papers contest of the AIEE District No. 8 on May 10 at the University of California at Berkeley.

Speaker at the banquet of the annual joint Spring meeting of the Arizona Section and the University of Arizona Student Branch AIEE was A. P. Kelley, assistant chief of preliminary design at the AiResearch Manufacturing Company, Phoenix, Ariz.

Mr. Kelley spoke on "The Current Outlook for Nuclear Power." His address included a discussion of the role of the electrical engineer in the nuclear power program, the development of package power plants, and some of the technical problems that may be slowing down the military reactor program.

Electrical engineers and students from throughout Arizona also heard Carl Foiles of Tucson, a senior in electrical engineering at the University of Arizona, present the second-place paper, "Spark Gap Marking of Teledeltose Paper." Mr. Foiles was awarded a $50 prize. The prizes were given by the Arizona Section of AIEE.

Mr. Kelley, a native of Washington, D. C., is a graduate of the United States Naval Academy. He served in the U. S. Navy during World War II, and was selected for special training at Massachusetts Institute of Technology, where he received his M.S. degree in 1946. After three years as a U. S. Navy representative on the U. S. Atomic Energy Commission, during which time he studied the effects of the Bikini atomic tests on target ships, he started an assignment in charge of nuclear development and testing of atomic power plants for the *USS Seawolf*, nuclear submarine.

During his final service with the Navy as Assistant to the Director of Naval Reactors, he published two books, "Nuclear Power for Ship Propulsion," and the "Shipyard Industrial Radiological Manual." He joined the staff of AiResearch in Phoenix in 1956 as a special assignments engineer in preliminary design.

Following the afternoon session on the University of Arizona campus, the engineers met for dinner at the Bagdad Room of the Tucson Inn.

Participating in the District No. 8 contest at Berkeley were representatives of the University of California at Berkeley, the University of Southern California, the University of California at Los Angeles, California Polytechnic Instute, California Institute of Technology, Stanford University, Santa Clara University, and the University of Nevada, as well as the University of Arizona.

Prof. J. L. Knickerbocker is adviser of the Arizona Student Branch of AIEE.

**CONGRATULATING** seniors in electrical engineering at the University of Arizona who were prize-winners for papers presented at the joint Arizona Section–Student Branch meeting of the AIEE, are: (*left to right*) J. L. Knickerbocker, assistant professor of electrical engineering and adviser to the student group; T. A. Phillips, chairman of the Arizona Section; and Bradley Cozzens, vice-president of District No. 8 of AIEE. On the stage are (*left to right*) L. E. Colip, and L. F. Cowden, first prize winners; and Carl Foiles, second prize winner.

## ASEE Sponsors Study of American Engineering Colleges

A $10,000 grant of the National Science Foundation will support the first phase of a comprehensive study of how engineering colleges in the United States may attract and keep top-flight engineering teachers for their growing numbers of students.

The American Society for Engineering Education (ASEE), sponsor of the project, says the Science Foundation grant will be used for preliminary work on a study ". . . to determine and describe in detail the character and magnitude of the manpower and related financial needs of engineering colleges . . ." and for organizing a full-scale attack on the problem.

When these needs are better understood, the ASEE project will go on to identify and specify the problems to be solved in meeting these needs, to determine and describe the special opportunities, satisfactions, and problems of engineering teaching, and to formulate the conditions which engineering colleges must fulfill to attract and develop good teachers for their faculties.

Dr. W. L. Everitt, dean of the College of Engineering at the University of Illinois and president of the ASEE, announced the grant of the National Science Foundation. "This study of recruiting, developing, and utilizing engineering faculties," he said, "comes at a time when the competition for men to serve in these faculties is becoming increasingly acute and when greatly increased numbers of students requiring even larger faculties in our engineering schools are in immediate prospect."

The ASEE project, titled officially "The Development of Engineering Faculties," is under the direction of an executive committee of which Dean H. L. Hazen of the Graduate School at the Massachusetts Institute of Technology is chairman. Dr. W. H. Miernyk of Northeastern University is executive director. The facilities of Northeastern's Bureau of Business and Economic Research, of which Dr. Miernyk is director, will be used.

The ASEE has the support of the Engineers Council for Professional Development (ECPD), Engineers Joint Council, and the National Committee for the Development of Scientists and Engineers in the

project, and the committee will work in "closest co-operation" with all other agencies concerned with problems of engineering and scientific manpower.

"The first step in the project," said Dean Hazen, "is to find out, in some detail, what shortages now exist and how great are the faculty needs now anticipated by engineering colleges." It is to start this study and to make detailed plans for subsequent phases of the project that the National Science Foundation grant is to be used.

Although the committee will study the results of all available recent surveys of engineering and scientific manpower, it is undertaking a special study of its own, covering all engineering colleges in the United States, to obtain statistics on the estimated needs for engineering teachers throughout the coming decades, their areas of special interest and competence, the qualifications they must have, their salary requirements, and—most important—the cost of meeting these needs.

In addition, to learn the many subtle and intangible aspects of this complex problem, the committee will make personal visits to a small but representative number of institutions.

"Only as these questions of needs have been thoroughly explored," said Dean Hazen, "will we begin to see how these needs may best be satisfied and what are the specific problems which should be of greatest concern."

The committee expects to make a progress report of its work at the ASEE Annual Meeting at Cornell University in mid June.

Other members of the project's executive committee are Dr. J. C. Boyce, vice-president of Illinois Institute of Technology; Dean G. B. Carson of the College of Engineering, Ohio State University; M. D. Hooven of the Public Service Gas and Electric Company, Newark, N. J., president of ECPD and past president of AIEE; and Dr. W. C. White, vice-president of Northeastern University.

## Student Branch Installed at the University of Buffalo

At the March 7 meeting of the Niagara Frontier Section of AIEE, an affiliate Student Branch was officially installed at the University of Buffalo. The first officers of this Student Branch are: M. W. Chudzik, chairman; Edward Dowski, vice-chairman; Tracy Gunderman, secretary; and Ronald Hettich, treasurer. Prof. F. P. Fischer, head of the electrical engineering department at the University is counselor.

The Affiliate Student Branch Charter was accepted by Dr. R. H. Heindel, vice-chancellor of the University, and M. W. Chudzik delivered a brief address in addition to Dr. Heindel's acceptance address. C. N. Hoyler of the Radio Corporation of America (RCA) Laboratories presented an excellent address and demonstration entitled "Adventure in Electronic Research."

## NYU Establishes Graduate Study Center at Bell Labs

A graduate study center will be established by New York University (NYU) at Bell Telephone Laboratories in the Fall of 1957. At the center, certain Laboratories employees will be able to earn advanced engineering degrees by attending classes during regular business hours while receiving full-time pay.

A committee of Laboratories scientists worked with the administration and faculty of the NYU College of Engineering in drawing up a program selected from regular graduate offerings of the University. These courses, emphasizing particularly mathematics, physics, and basic communications, are designed to develop a strong background for engineers embarking on careers in creative work in the field of communications.

Announcement of the new educational program was made jointly on April 23 by President C. V. Newsom of NYU and Dr. M. J. Kelly, president of Bell Telephone Laboratories.

The NYU program, offered under the Graduate Division of the College of Engineering, will replace a part of the Communications Development Training program (CDT) now in operation at Bell Laboratories. The Laboratories' program was established in 1948 as a three-year company course to provide additional education and training for newly employed engineers.

The CDT program at the Laboratories will continue and will offer courses in areas of specific interest to the Bell System. The two programs will complement each other and will constitute an integrated course of graduate study and training in industry. Participants will receive full salary while studying and working part time in Laboratories technical departments. The cost of instruction will be borne entirely by the Laboratories.

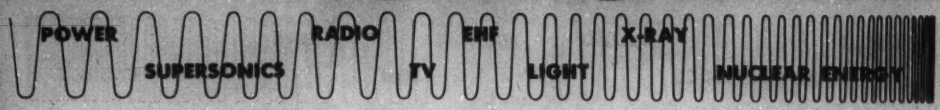
In recent years, NYU has co-operated by providing instructors for certain mathematics and physics courses of the Laboratories' program. The new educational plan is an extension of this earlier co-operation. The University will have a full-time director of the branch at the Laboratories, and the courses offered for graduate credit will be taught by regular members of the University's faculty.

The courses planned initially will lead to the M.E.E. degree which can be obtained in two years by those able to satisfy the requirements of the NYU College of Engineering. Those who already have master's degrees and those who wish to qualify for degrees in fields other than electrical engineering can also accumulate

*Courtesy University of Buffalo Audio-Visual Center*

**ON MARCH 7, the AIEE Niagara Frontier Section presented an Affiliate Student Branch Charter to the University of Buffalo. Among those at the presentation were: (*left to right*) R. A. Beuerman, E. I. du Pont de Nemours & Co. (Inc.), past chairman; Prof. F. P. Fischer, head of the electrical engineering department; M. W. Chudzik, first chairman of the Affiliate Student Branch; Dr. R. H. Heindel, vice-chancellor of the University of Buffalo; and D. J. Munhall, chairman of the Niagara Frontier Section.**

# Electrical Engineering Education




graduate credits toward a doctorate or toward other graduate degrees. To complete the requirements for such degrees, courses in any field may be taken on the NYU campus under Bell Laboratories' Graduate Study Plan, which provides tuition refund and limited time off with pay for employees attending nearby universities.

The first group to have the opportunity of entering fully into the new program will be the graduates of various engineering schools who will begin their work at the Laboratories this year. For new employees lacking full prerequisites for the program, NYU will provide special courses during the summer months.

Classroom and office space for the NYU branch and other training activities is planned in the new administration building now under construction at the Laboratories' Murray Hill, N. J., location. Until this space is available early in 1958, classes will be held at 180 Varick St. in New York, N. Y.

## AES "Mobile Laboratory" Promotes Interest in Science

In the first phase of a concerted drive to interest young people in scientific and engineering careers, the Aircraft Electrical Society (AES) has installed modern electrical, electronic, and radio equipment in a 20-foot mobile trailer for use in public schools, youth, and Boy Scout camps throughout the southern California area, AES President R. H. Summerl has announced. The workshop on wheels is the first of six proposed mobile laboratories to be used by the society in its effort to interest more youths in science, Mr. Summerl stated.

The program will be under the over-all direction of R. C. Baker, Westchester High School science teacher, and operations chairman of the Science Fair Exhibit, conducted annually in Los Angeles, Calif.

The mobile laboratory, complete with work benches and cabinets, will visit public schools and public school camps during the academic year, and YMCA and Boy Scout camps during summer vacation months.

The trailer will be exhibited at the AES 14th Annual Display of Aviation Electrical Equipment October 24-25 in the Pan Pacific Auditorium, Los Angeles.

Equipment to be housed in the trailer includes amateur radio receiving and transmitting equipment, code practice equipment, directional radio compass, geiger counters, blacklight, automatic weather recorders, six-inch telescope with clock drive mechanism, and graphic recorders. During the summer program, small electrical and radio kits will be available for construction on a competitive basis.

The AES is a nonprofit national organization incorporated in California, and designed to promote recognition of aviation electricity while providing a medium for the interchange of ideas and information. Membership consists of engineering, production, sales, service, and flight personnel in aircraft and equipment manufacturing, airlines, or related industries.

## VEF Aids in Overcoming Engineering Personnel Shortage

In the State of Virginia, positive steps are being taken to help overcome one of industry's growing problems—the shortage of qualified engineering personnel. A nonprofit corporation, The Virginia Engineering Foundation (VEF), has been established to aid and promote, by financial assistance and otherwise, all types of engineering education and research at The University of Virginia School of Engineering and its Engineering Experimental Station at Charlottesville, Va. The VEF itself operates independently of the University under the control of an industrial Board of Trustees.

Funds donated by companies or individuals may be used in a variety of ways, including a general VEF Scholarship Fund, expansion of faculty and facilities, and grants for special research by the Experimental Station. This research includes contracts in electrical, chemical, and mechanical engineering projects, as well as nuclear physics and engineering projects facilitated by the recent acquisition of an operating nuclear reactor. Any donor is free to designate the use of his contribution, subject only to the action of the VEF Board of Trustees within the framework of the University's operations. Inquiries are invited through The Executive Secretary, Virginia Engineering Foundation, Box 3323, University Station, Charlottesville, Va.

**AT A RECENT U. S. Naval Postgraduate School AIEE Student Branch Meeting were: (*left to right*) Lt. E. M. Baty, U.S.N., chairman of the Student Branch; Prof. Charles Dalziel, University of California, who spoke on "Effects of Electric Shock on Man"; and Associate Professor C. B. Oler, counselor of this Student Branch.**

## Prof. Dalziel Visits Branch at Naval Postgraduate School

Prof. Charles Dalziel (M '39) of the University of California, spoke on "The Effects of Electric Shock on Man," at a meeting of the AIEE Student Branch of the U. S. Naval Postgraduate School, Monterey, Calif., April 5, 1957. Prof. Dalziel, a noted authority in this field, has published numerous papers and addressed many groups on this universally interesting subject. A large attendance was augmented by the maintenance and installation employees of the Naval School, for whom the talk had particular significance. Prof. Dalziel stressed the importance of prompt and effective artificial respiration in cases of shock. He also emphasized that many industrial accidents involve bodily injuries sustained through falls or violent muscular reactions of persons subjected to relatively minor electrical shock.

Prof. Dalziel was accompanied on his

trip by Prof. Whinnery, also of the electrical engineering department at the University of California. They took this opportunity to make a tour of the electrical engineering facilities at the Naval Postgraduate School.

## Kansas City Section Holds Student's Night

The regular May meeting of the Kansas City Section was devoted to student activities. Papers were presented by students from Kansas University and Kansas State College, and the five award winners from the Science Fair with their sponsors were guests of the Section at the dinner meeting, May 9, attended by over 100.

During the Science Fair, the Kansas City Section had a committee judge the exhibits. First prize was a $25 Savings Bond and second prize was $10. O. A. Starcke, chairman of the Judging Committee, presented certificates and prizes to the high school students at the meeting. The winners were: First Prize—Kenneth Concannon, Grandview High School, for his exhibit on "Cybernetics"; Second Prize—Kenneth McQuarrie, Center High School, for his exhibit on "Flood Control and Production of Electric Power." Honorable Mentions were given to D. W. Davis, Park Hill High School, for his exhibit on "The Electron Microscope"; David Foster, Southwest High School, for his exhibit on "Transistorized Metal Locator"; and R. L. Bland, Central High School, for his exhibit on "Taking a Look at Sound."

D. C. Williams, chairman of the Meetings and Papers Committee, introduced the speakers. Two papers were presented for the annual Student Paper Competition. First prize went to C. O. Pingry, University of Kansas, for his paper entitled "Automatic Telephone Dialer." Second prize went to E. M. Hammeke, Kansas State College, for his paper on "Direct Distance Dialing." Two other noncompetitive papers were presented by students with John DeMarco of the University of Kansas talking on "Unionization of Engineers" and R. H. Updyke, Kansas State College, speaking on "Heat Pumps."

Since this was the final meeting of the year, Chairman E. L. Sitz of Kansas State College introduced the new officers for the next year. They are: Chairman R. M. Goar, Black and Veatch Co.; Vice-Chairman H. R. Vaughan, Westinghouse Electric Corporation; and Secretary E. L. Mueller, Kansas City Power & Light Co.

## NCE To Participate in Westinghouse Graduate Program

R. W. Van Houten, president of Newark College of Engineering (NCE), has announced that starting in September 1957 NCE will participate in the Westinghouse graduate education program in addition to the undergraduate program now in effect at the college.

Representatives of Westinghouse offices and plants in New Jersey met with company and college officials at a luncheon in Newark's Military Park Hotel on April 22 to discuss the details of the plan.

Under the program, operative in 19 colleges and universities throughout the country, Westinghouse offers its 130,000 employees tuition refunds for undergraduate and graduate courses taken toward academic degrees in engineering, physics, mathematics, or business administration. Since the plan's inception in 1939, more than 8,000 Westinghouse employees have participated in the undergraduate program, and more than 400 have obtained advance degrees. In New Jersey, the plan is also in effect at Rutgers University and Stevens Institute of Technology.

In addition to President Van Houten and plant representatives, the luncheon was attended by William Hazell, Jr., NCE dean of administration; C. H. Stephans, director of industrial relations at the college; and R. C. Fabian, Westinghouse supervisor of university relations.

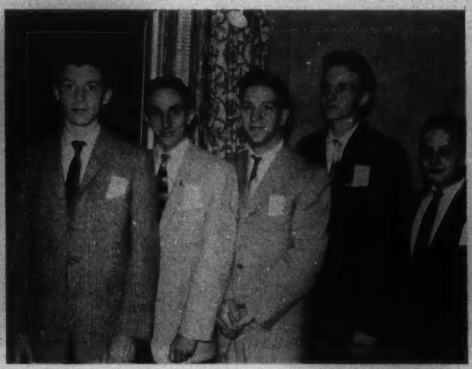
## Eta Kappa Nu Chapter Recently Installed at SMU

Monday evening, May 6, marked another milestone in the development of the Engineering School at Southern Methodist University (SMU) with the installation of a chapter of the Eta Kappa Nu honorary electrical engineering society.

The Epsilon Epsilon Sigma Association of undergraduate electrical engineering students petitioned for the formation of the Eta Kappa Nu Chapter. The local honorary society has 26 members who became members of the national Eta Kappa Nu Society. Prof. F. W. Tatum is the faculty adviser for the local honorary association.

Dr. J. D. Ryder of Michigan State University, who is national executive president,

*Courtesy S. H. Pollock*



*Courtesy S. H. Pollock*

**WINNERS of the Kansas City Section Student Prize Paper Competition (*above, left*) with Section Chairman E. L. Sitz (*center*). E. M. Hammeke (*left*) of Kansas State College received second prize and C. O. Pingry (*right*) of the University of Kansas won first prize. Above, *right*: Winners of the Science Fair awards offered by the Kansas City Section were: (*left to right*) first prize, Kenneth Concannon; second prize, Kenneth McQuarrie; honorable mentions, D. W. Davis, R. L. Bland, and David Foster. Awards were presented at a "Student's Night" Meeting.**

and A. B. Zerby of Dillsburg, Pa., who is national executive secretary of Eta Kappa Nu, were present at the initiation and installation. Dr. Ryder also was the main speaker at the banquet following the initiation in the Umphrey Lee Student Center. The topic for Dr. Ryder's talk was "Problems for Tomorrow."

Honored guests at the banquet were Dr. W. M. Tate, Rev. Sterling Wheeler, Dr. Hemphill Hosford, Dean E. H. Flath, Dr. Mayne Longnecker, Dr. D. W. Starr, heads of the departments in the school of engineering, and presidents of the other honorary societies in the engineering school. Also present were representatives from Texas Tech, the University of Texas, A. & M. College of Texas, University of Oklahoma, and Oklahoma A & M.

The officers of the petition group were R. E. Stapleton, president; L. C. Watson, vice-president; D. C. Donohoe, secretary; and S. H. Middings, treasurer. At the initiation and banquet, R. E. Stapleton served as master of ceremonies.

Two alumni members were initiated at the ceremony. G. A. Smith, prominent Dallas, Tex., engineer, who is a graduate of the Catholic University of America and D. J. Tucker, manager of radio station WRR and an SMU graduate became members of Eta Kappa Nu.

Undergraduate students from Dallas initiated were J. S. Barnett, C. F. Brown, J. T. Dean, A. B. Denman, B. F. Elfant, R. B. Hemphill, Clem Jones, J. B. Jones, Monroe McDonald, C. D. Morrow, S. H. Middings, R. B. Schell, R. E. Stapleton, K. R. Tipple, L. C. Watson, J. G. White, and R. G. Wright.

Other students initiated into Eta Kappa Nu were D. A. Davis, Williston, N. C.; D. B. Doan, Arlington; D. C. Donohoe, Cisco; R. G. Downing, Arlington; W. B. Ford, Grand Prairie; J. B. Haisler, Denton; R. C. Heidt, Arlington; D. W. Koshi, Keolakakua, Hawaii; J. B. Shipley, Garland; J. R. Waller, Macon, Mo.; and G. C. Wetsel, Plano.

## Stevens Institute Constructs New Science-Engineering Building

Stevens Institute of Technology has begun construction of a modern, seven-story Science-Engineering building, it was announced recently by Dr. J. H. Davis, president of the college.

The proposed $2 million structure will gather under one roof the Institute's departments of physics, metallurgy, and electrical engineering, in an effort to foster a closer working relationship between scientists doing research in different disciplines.

The personal exchange of ideas and information which thus will be encouraged is expected to be of particular benefit to the 87-year-old college at Castle Point which has always maintained a single, integrated curriculum of scientific and engineering studies for all of its undergraduates.

A cornerstone for the new building was laid on May 18 as a highlight of the annual Alumni Day ceremonies. The proposed construction schedule calls for the entire structure to be finished and ready for occupancy by the Fall semester of 1958.

The building will be L-shaped and will provide 100,000 square feet of space—doubling the laboratory facilities now available to each of the three departments. It was designed by J. J. McNamara, architect, New York, N. Y.

Among its features will be a one-story lecture hall, squaring out the space within the main L of the biulding. The hall will be air-conditioned, easily adaptable for motion picture projection, and will seat 250 persons. On the seventh floor, a 1,600-square-foot room will be provided for symposia and meetings.

The work area of the building will be divided among the departments by floors. The basement, most of the first, and all of the second floor will be used by the electrical engineering department for its laboratories and computation rooms. A new servomechanisms laboratory will be set up in this area.

The third and fourth floors will be used by the metallurgy department which is conducting research into high-speed and high-temperature metals as well as new techniques in powder metallurgy. The fifth, sixth, and seventh floors will house the physics department which is conducting research in nucleonics and low temperatures.

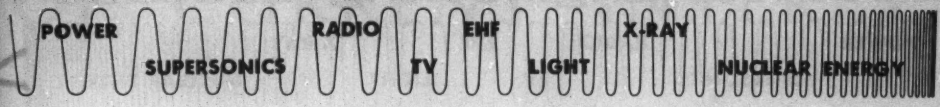
*Courtesy Ross Photos*

**THE BELL SYSTEM plays host to District No. 3 Prize Paper Winners: (seated, *left to right*) F. O. Bartholomew, fourth prize, Rutgers University; Howard Cohen, third prize, New York University Day Division; Nicholas Kfoury, first prize, New York University Evening Division; W. G. Schmidt, Jr., second prize, Manhattan College; W. K. MacAdam, American Telephone and Telegraph Co.; Prof. R. T. Weil, Jr., Manhattan College; (*standing, left to right*) W. A. Clark, chairman New York Section; Prof. M. A. Zaret, Cooper Union; Prof. C. W. Nisteruk, Manhattan College; Prof. D. Vitrogan, Pratt Institute; L. J. Hollander, chairman District No. 3 Committee on Student Activities; R. A. Deller, Bell Telephone Laboratories; L. F. Stone, vice-president District No. 3; Prof. J. R. Rankin, Rutgers University; and E. E. Bartleson, American Telephone and Telegraph Co.**

## Over 300 Students Attend AIEE-IRE Prize Paper Contest

Over 300 students attended the third annual Student Prize Paper Contest held jointly by AIEE District No. 3 and Institute of Radio Engineers (IRE) Region-No. 2 on April 12 at the Polytechnic Institute of Brooklyn. Amid unprecedented competition for prizes worth more than $675, a New York University Evening Division student, Nicholas Kfoury, brought top honor to his school with his paper "Analog Computer Control for Compound Aircraft Machining."

The second prize went to W. G. Schmidt, Jr., of Manhattan College for his paper "An Asynchronous Simultaneous-Carry Parallel Adder." A third prize was taken by Howard Cohen of New York University (Day Division) for his paper "A Study of the Application of the Analog Computer in Determining the Transfer Functions of Two




Terminal Pair R, L, and C Networks through the Use of Pole-Zero Concepts." A Rutgers University student, F. O. Bartholomew, received fourth prize for his paper "Information Theory Applied to Mechanical Music Composition."

Through the generous co-operation of the New York Sections of the AIEE and IRE, Mr. Kfoury's prize included a $500 scholarship for graduate study. The three other prizes were in cash in the amounts of $100, $50, and $25, respectively. In addition, each of the prize winners were the guests of the Bell System for an inspection trip to the Bell Telephone Laboratories at Murray Hill, N. J.

## Engineering Scholarship Announced by Providence Section

The Providence Section of the AIEE announced, on April 9 at its meeting in the Providence Engineering Society Auditorium, the establishment of an engineering scholarship to be awarded during the coming year. The grant of $500 is intended to assist an engineering student of limited means in furthering his education.

The announcement was one of the highlights of the organization's annual "Student Night" program which was attended by over 100 electrical engineering students and members, and was preceded by a dinner for the students in the President's Dining Room at the Sharpe Refectory at Brown University.

Other features of the meeting included the award of prizes for the Section's Technical Papers Contest held in February, and the Student Papers Competition held in March.

In the Section Contest, H. T. Knox of Bristol, R. I., was awarded first prize of $50 for his paper "Current Carrying Capacities of Three Single Conductor Aerial Cables." E. E. Linden of Cranston, R. I., received second prize of $30 for his paper "Heat Pump and Heating Cables Installed in the Same Residence for Data Purposes." Third prize of $20 went to P. E. Bernier of Pawtucket, R. I., for his paper "Lightning Storm Finder." The prizes were presented by D. E. Garr of Schenectady, N. Y., District vice-president of the Institute.

Prizes for the student competition were presented by P. H. St. Pierre of Wickford, student activities chairman. First prize went to D. J. Morrison of The New Bedford Institute of Technology for his paper "The Binary Number System." Fernando Neves of Bradford Durfee Technical Institute was awarded second prize for his paper on "Loran," and Paul Crepeau of the University of Rhode Island received third prize for "An Application of Boolean Algebra to Switching Circuits." Louis Martinage and Peter Rosenfeld of Brown University received honorable mention for their joint paper "Use of a Light Beam Carrier for Audio Transmission."

Principal speaker of the evening was C. P. Corey of Millbury, Mass., chief system dispatcher of the New England Electric System, who described the problems involved in operating a large interconnected power system and some of the modern methods of solution.

In announcing the scholarship grant, Mr. Linden, the Section chairman, and E. W. Roberts, Jr., of Cranston, scholarship chairman, described it as an attempt to make some definite and immediate contribution toward alleviation of the prevailing shortage of qualified engineers. They expressed the hope of the group that this action might serve as encouragement to other organizations to consider establishment of similar grants.

## Nation's First Engineering Secretarial Students Graduate

The first engineering secretarial students in the nation were graduated in June from the Business Training College (BTC) in Pittsburgh, Pa. The graduates were Patricia Shafley, J. W. Sneddon, and Kay Jack.

These are the first three students to complete the two year engineering secretarial course established in 1955. It is the only such course in the country. In 1958, 22 juniors will be graduated. BTC's engineering secretarial course was patterned after the successful medical secretarial course which has been given at the college for more than 15 years.

The engineering secretarial course features extensive training in engineering terminology, complete mastery of the secretarial skills, instruction in physical sciences, chemical experiments, slide rule, drafting, blue print reading, and visual aids. Guest lecturers address the students on engineering subjects during the entire two year program and field trips are arranged. This training enables graduates to serve as administrative assistants and aides to busy engineers.

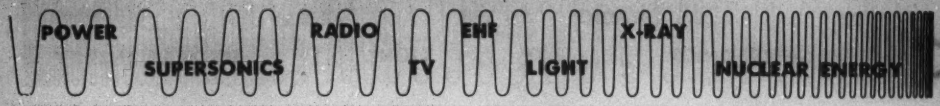
During the summer, between the junior and senior years, students are placed in engineering and professional positions, full or part time, thereby enabling them to gain additional terminology. At the same time, they learn more of the administrative and business office techniques of the profession. A lifetime free placement service keeps the students and graduates fully informed of positions and opportunities available in the United States and abroad.

## District No. 2 Student Paper Contest

*Photograph by Denis Kawahara*

**A GROUP of the participants and counselors from schools represented at the AIEE District No. 2 Prize Paper Competition. The contest was held at Villanova University on April 26, 1957, with 11 schools represented. The winners were: J. T. Raleigh, Pennsylvania State University, first place, "A Classroom Communication System for Use with Closed Circuit Television Instruction"; S. S. Wolff, Swarthmore College, second place, "Some Considerations in the Design of a Selective Feedback Amplifier"; and D. C. Dillon, West Virginia University, third place, "The Nimskull."**

# Electrical Engineering Education




## R. T. Denton Receives NEC Fellowship in Electronics

A University of Michigan student has been awarded the National Electronics Conference (NEC) fellowship in electronics for the 1957-58 academic year.

The award is the first to be given under a recently adopted program for sponsoring advanced study in electronics, according to Dr. C. E. Barthel Jr., conference president.

The winner, chosen in national competition, is R. T. Denton, currently working toward a doctor's degree in electrical engineering. He received master and bachelor degrees at Pennsylvania State University. Mr. Denton plans study in electronic systems analysis and design.

The NEC fellowship, worth $2,500, is for a year of graduate study at any of eight colleges and universities participating.

These include Illinois Institute of Technology, Northwestern University, and University of Illinois as sponsors, and Michigan, Michigan State, Purdue, Notre Dame, and Wisconsin Universities as co-operating institutions.

The sponsoring group also includes the AIEE and Institute of Radio Engineers, with the Radio-Electronics-Television Manufacturers Association and Society of Motion Picture and Television Engineers as participating members.

The National Electronics Conference is held annually in Chicago, Ill., for discussion of advances in electronic research, development, and application.

The 1957 meeting—the 13th—will be held on October 7-9 at the Hotel Sherman.

## National Conference on Technical Education Planned

J. E. Harrington, executive secretary of the Western Society of Engineers has announced that the Western Society will provide local sponsorship in Chicago, Ill., for a comprehensive conference on the fundamental status of higher education in relation to engineering, science, and technology. The meeting will be held at the Edgewater Beach Hotel in Chicago, Ill., October 31—November 2, 1957. It will be sponsored by the Engineers Joint Council, the Scientific Manpower Commission, the National Science Foundation and the National Academy of Sciences—National Research Council.

The theme of the National Conference will be "Engineering and Scientific Education—Foundation of National Strength."

According to Mr. Harrington, the conference will: (1) provide an up-to-date picture of the technical manpower problem and its implication for educational resources, (2) highlight the unique problems of higher education in engineering and science and explore remedial measures, and (3) contribute to general understanding of problems of higher education in technology and the need to rally the Nation's resources to meet the challenge.

Mr. Harrington indicated that program planning is well along and that an outstanding group of educational, industrial, and Governmental leaders is being assembled. Dr. Lee DuBridge, president, California Institute of Technology will deliver the keynote address.

## Dr. Michaels To Teach College Classes in Finland

Dr. E. L. Michaels (M'53), nationally recognized authority on electronics and color television, will teach college classes this Fall and Winter in Helsinki, Finland, during a leave of absence from Hughes Aircraft Company research laboratories. Dr. Michaels, who was awarded a Fulbright scholorship recently, will teach electrical engineering classes at the Finland Institute of Technology. His salary and transportation expenses for the nine-month stay will be paid by the Fulbright scholarship.

Last year, Dr. Michaels lectured on electronics to physics students in Los Angeles, Calif., high schools as part of a joint Hughes–City program to induce more young people to choose careers in science. He currently is a part-time teacher of electronics at the University of Southern California in addition to his research work at Hughes.

## New Board Members Elected by Instrumentation Foundation

The recently created Foundation for Instrumentation Education and Research announced the election of four new members to its Board of Trustees. They are Dr. G. S. Brown (F'50), head of the electrical engineering department, Massachusetts Institute of Technology; W. W. Garey, publisher of *Control Engineering* magazine, McGraw-Hill Publishing Company; Dr. C. C. Hurd, director of automation research, International Business Machines Corporation; and Dr. A. B. Kinzel, vice-president—research, Union Carbide Corporation.

The Foundation for Instrumentation Education and Research is a nonprofit philanthropic agency sponsoring and catalyzing educational projects and basic research in the engineering-science of instrumentation and automatic control, or automation. It was formed as a corporate body in New York State on February 18, 1957, through an initial grant of $40,000 from the Instrument Society of America, the engineering society of this new field. It is governed by a Board of Trustees gathered from Government, education, research institutes, and various industries using automation.

Current projects of the Foundation include the administering of graduate fellowships for basic research in various phases of automation technology, and clinics which bring together leading instrumentation development engineers with research people in such fields as medicine and biology. The first clinic, a group meeting to explore new measuring techniques for unsolved physical and chemical variables in human sickness and disease, took place in Ridgefield, Conn., on June 10-11.

## H. A. Peterson Receives Benjamin Smith Reynolds Award

H. A. Peterson (F '47), professor and chairman of the department of electrical engineering in the University of Wisconsin (UW) College of Engineering, was awarded the annual Benjamin Smith Reynolds Award of $1,000 for excellence in the teaching of future engineers.

The award, established three years ago by the family and friends of Benjamin Smith Reynolds, widely known Madison manufacturer who died in 1954, was given to Prof. Peterson at a dinner climaxing UW's ninth annual Engineers' Day program.

Some 400 engineers and industrialists from all parts of the state and nation witnessed the presentation of the award.

The presentation was made by Charles Gelatt, La Crosse, president of the UW Board of Regents, who said that Prof. Peterson

> ". . . is rated by colleagues and students alike as a great teacher of undergraduates, and one whose counsel and guidance many students seek and hold. At the same time, a list of the men who have earned their Ph.D.'s under his guidance range today from distinguished full professors at other institutions to highly placed industrial engineers."

Born on a farm at Essex, Iowa, Prof. Peterson gained both his bachelor's and master's degrees in electrical engineering at the University of Iowa. He was on the staff of the General Electric Company, from 1934 until he joined the UW faculty in 1946. Prof. Peterson's special field is analytical engineering and he is the author of more than a score of highly technical papers in the field. Last January he was cited as "Engineer of the Month" by the official publication of the Engineers' Society of Milwaukee.

# OF CURRENT INTEREST

*CRUISER* U. S. S. Canberra *is equipped with a long-secret class of super-radars whose antennas resemble gigantic searchlights.*

*Sperry Gyroscope Co. Photo*

## Missile Ship Super-Radars Are Revealed by U. S. Navy

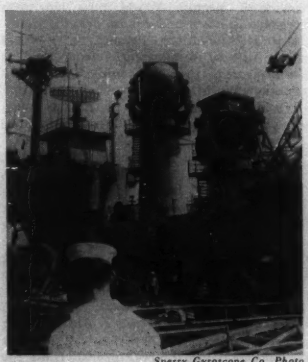
A LONG-SECRET CLASS of super-radars—now in service with the fleet for guidance of its Terrier missiles—was revealed recently by the U. S. Navy.

Subject of speculation since first displayed aboard the guided missile cruiser *U. S. S. Canberra (CAG2)*, massive, turret-like antennas for the new radars have radically changed the contours of the nation's fighting ships. Although the radar antennas, which resemble gigantic searchlights, attracted considerable attention during President Eisenhower's recent trip on the Terrier-equipped *U. S. S. Canberra*, this announcement was first to identify the structures. Only limited general information regarding the new *AN/SPQ-5* radars was released, however.

### Developed for U. S. Navy

Developed for the U. S. Navy by Sperry Gyroscope Company, Great Neck, N. Y., the long-range, high-altitude missile guidance radar systems came into fleet use only after years of successful tests. According to Rear Admiral F. S. Withington, chief of the U. S. Navy's Bureau of Ordnance, the *SPQ-5* Terrier radars "provide the navy's newest missile ships with added punch and power through increased accuracy and range."

Adm. Withington added that the new super-radars were a part of the navy's program directed toward providing the fleet with highly reliable missiles to combat supersonic jet aircraft. "Our new radar systems," he said, "are giving exceptionally high performance for tenacious, stable guidance of supersonic missiles, whether fired singly or in salvoes at individual or multiple enemy attackers." He confirmed that the two *SPQ-5* systems aboard the *U. S. S. Canberra* combine many automatic radar functions in each unit. Either system can control the missiles from a single launcher or battery, which fires the Terrier missile, or both radars can track different target groups simultaneously.



*Sperry Gyroscope Co. Photo*

**RESEMBLING gigantic searchlights, massive, turret-like structures aboard the U. S. Navy's missile ship *U. S. S. Canberra* have been identified as super-radar antennae for guidance of Terrier missiles.**

### Flexible Scanning

The *SPQ-5* radar systems include flexible modes of scanning the air space many miles beyond the horizon, providing the advantage of early warning. Individual targets can be selected from close-flying groups and tracked at great distances while the missiles are launched and guided with "accuracy."

Concurrently, it was announced that a new manufacturing facility at Charlottesville, Va., The Sperry Piedmont Company, is producing the super-radars for the navy. Completed in October 1956, the plant includes special facilities to accommodate the massive radar antennae "barbettes" used aboard ship.

Two cruisers, the *U. S. S. Boston* and the *U. S. S. Canberra*, have been converted to Terrier-equipped missile ships and have joined the fleet.

# International Geophysical Year

## Developments and Opportunities

OPPORTUNITIES exist in the Antarctic program planned by the U. S. National Committee for the International Geophysical Year (IGY) 1957-58, for scientists, engineers, and technicians at the bachelors, masters, and doctorate levels of training and experience in physics, geophysics, electronics, or closely allied areas. The IGY is a study of the physics of the earth in which more than 50 nations are collaborating. The U. S. Antarctic program emphasizes the following fields: Aurora and Airglow, Cosmic Rays, Glaciology, Gravity, Ionospheric Physics, Meteorology, and Seismology. Most of the current openings exist in the fields of meteorology and glaciology, although the other fields still require a limited number of specialists.

Research stations have been established at Little America on Marie Byrd Land (Byrd Station), at the South Geographic Pole (Amundsen-Scott South Pole Station), on the Knox Coast (Wilkes Station), and along the Weddell Sea (Ellsworth Station).

The first group of scientists and technicians are now on-station and geophysical observations and studies are presently under way. The program of observations will continue until April 1959. A second group will leave the United States about November 1, 1957. Prior to departure, approximately two months of advanced training will be provided in problems of research, instrumentation, and operations in polar regions.

Interested candidates are invited to address inquiries to the following Antarctic Project Leaders:

*Aurora and Airglow:* N. J. Oliver, A. F. Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Mass.

*Glaciology, Gravity, and Seismology:* Miss Diana Fisher, Glaciological Headquarters Office, USNC-IGY, Room 716, 1145 19th St., N. W., Washington 6, D. C.

*Ionospheric Physics:* H. G. Sellery, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colo.

*Meteorology:* E. A. Volbrecht, U. S. Weather Bureau, 24th & M Sts., N. W., Washington 25, D. C.

### IGY World Warning Agency

Beginning July 1, 1957, the National Bureau of Standards (NBS) radio forecasting center at Fort Belvoir, Va., will serve as the focal point of a world-wide communications network for the IGY. From this point, warnings will be flashed to scientists throughout the world to redouble their observational efforts in anticipation of unusual activity in their fields.

The warnings will be based mainly on world-wide observations of the surface of the sun and on soundings of the ionosphere, the electrically charged upper portion of the atmosphere. When the surface of the sun erupts, shooting out flames for hundreds of thousands of miles, the earth's atmosphere is showered with vastly increased quantities of particles from outer space. This solar bombardment not only causes magnetic compasses to misbehave but also produces brilliant displays of Northern Lights and causes changes in radio communication through its effect on the ionosphere.

The NBS field station has been selected as the IGY World Warning Agency by the U. S. National Committee for the IGY. Organized by the National Academy of Sciences–National Research Council, the U. S. National Committee is planning and directing United States participation in the IGY under the chairmanship of Dr. Joseph Kaplan. The world-wide warning network is under the general direction of A. H. Shapley of the NBS Boulder (Colo.) Laboratories, who is serving as vice chairman of the United States National Committee for the IGY and international co-ordinator of IGY communications. The IGY World Warning Agency at Fort Belvoir is headed by R. C. Moore of the NBS staff.

The internatonal network includes the radio teletype network of the World Meteorological Organization, virtually all of the commercial communications facilities throughout the world, government facilities (such as military channels and in the United States, the Civil Aeronautic Administration), and special messages broadcast by stations WWV and WWVH (on the NBS radio propagation forecast channels) and their counterparts in other countries. This elaborate and far-reaching network has been set up so that IGY scientists, no matter how remote the site of their work—from Arctic outposts to Pacific islands or the Himalayas—can conduct their experiments simultaneously. Since January 1957, the warning system has been undergoing a week of advance trials each month.

Because it is economically unfeasible for scientists to make intensive world-wide observations every day during the IGY, a series of Regular World Days has been selected in advance for more detailed simultaneous observations. These Regular World Days will be supplemented from time to time by two types of warnings—Alerts and Special World Intervals—which the IGY World Warning Agency will issue when major solar-terrestrial disturbances are expected.

IGY programs in ionospheric physics, geomagnetism, solar activity, cosmic rays, and aurora will be intensified during Special World Intervals. Some special cosmic ray balloon flights and rocket launching may be made during these periods, with experiments on a stand-by basis, awaiting notification of special conditions from the world warning center.

By 1,600 GMT (Greenwich Mean Time) each day, scientists at the World Warning Agency will decide whether to call an Alert or Special World Interval for 0001 GMT the following day or not. This decision will be made with the advice of ionospheric and solar observatories and communications forecasting centers both in the United States and abroad.

If solar conditions justify calling an Alert or Special World Interval, the World Warning Agency will issue messages to Regional Warning Centers in The Netherlands, France, Germany, Japan, and the U.S.S.R., and then to Associate Warning Centers in Australia, Antarctica, and Alaska. From these centers, the warnings will be flashed to every IGY field station throughout the world.

The forecasting center in Virginia will also serve as the Western Hemisphere Regional Warning Center. In the United States itself, messages will be put on the U. S. Weather Bureau communications system, so that all U. S. Weather Bureau stations will be alerted. It is then the task of each Weather Bureau station to inform all the other IGY field stations in its locality. The special radio propagation transmitting stations—WWV and WWVH in the United States, IOL in Argentina, and JJD in Japan —are expected to serve as a secondary method of informing the world IGY stations of Alerts and Special World Intervals.

### IUGG General Assembly

At a world gathering of scientists in Toronto, Ont., Canada, E. I. Tolstikov of the U.S.S.R. will speak on the subject of Arctic and Antarctic investigations of the IGY. His illustrated address will be given at the 11th General Assembly of the International Union of Geodesy and Geophysics (IUGG) which meets in Toronto, September 3-14, 1957. Mr. Tolstikov is deputy head of the Soviet Central Department for the Arctic Seaway by which ships pass north of Siberia from European U.S.S.R to the Bering Sea and Pacific Ocean.

Another feature lecture at the Assembly will be given by Dr. L. V. Berkner, an American who is president of the International Council of Scientific Unions, the central world organization which sponsors the IGY. Dr. Berkner will describe the IGY rocket and satellite programs. Both these addresses will be open to the public. Other papers and discussions are on research which is of importance to such fields as aviation, exploration for oils and minerals, navigation, weather forecasting, and radio communications.

The 11th General Assembly of the IUGG will bring to Toronto about 1,500 scientists from 45 countries in order to discuss the 18-month IGY project being undertaken by 50 nations to investigate the earth's natural phenomena.

At its September Congress, the IUGG, which is one of the large international organizations sponsoring the IGY, will exchange latest information about the earth. A few of the subjects to be discussed are the earth's interior, its "polar wandering," its probable age, and its "water balance."

The earth's interior is investigated by studying shockwaves from earthquakes. These waves travel through the earth and like X rays reveal facts about the liquid core, the intermediate layer of heavy rock, and the thin outer crust of surface rocks.

Another special study, that of rock magnetism, may hold the secret of the much debated problem of whether the continents have always been fixed or whether they have drifted slowly apart. One widely held view is that, although the continents have remained in the same position relative to each other without any drifting, the earth's

axis may have moved relative to the continents. If the north and south poles have wandered in this way, it would explain why the arctic and antarctic regions were once temperate or tropical and why there were once ice sheets in regions now warm.

Recent discoveries in dating rocks have been made from radioactive elements found in the rocks. During the past two years this technique has established the age of the earth to be about 4½ thousand million years.

# Highlights of U. S. World Trade Fair

THE UNITED STATES World Trade Fair, displaying $500 millions in goods and services from 60 countries of the world ran from April 14th through April 27th, at the New York Coliseum.

Called the largest exposition for the world's merchandise that was ever held in the Western Hemisphere, the Fair attracted buyers from retail, distributor, and wholesale organizations all over North and South America.

First event on the official Fair schedule was a press preview.

This was followed after a proclamation by Mayor R. F. Wagner of New York, N. Y. by the U. S. World Trade Fair Ambassadors Dinner and Ball in behalf of the "March of Dimes" which was held at the Starlight Roof of the Waldorf-Astoria. Guests included Ambassadors and representatives of participating countries and visiting dignitaries from all over the world.

Official opening ceremonies were held April 14, at the entrance to the Coliseum. Keynote was the "breaking of bread"—the largest loaf ever baked—symbolizing the relationship of the U. S. World Trade Fair to World Peace and Prosperity.

A Fireworks display from barges in the middle of the Hudson River on April 15th, was featured through the courtesy of the Japanese External Trade Recovery Organization. Some 2½ tons of fireworks, the first such event in New York City proper for 30 years, were set off.

### Tower of Babel

To help those buyers who could speak only one language but who wanted to negotiate multilingually, interpreters were on hand who knew how to describe a bicycle pump, a shaving brush, a check writer, a shotgun, or the delights of cheese—among other things—in several languages.

There were 42 nations participating with National pavilions; 18 others were represented commercially. The 60 nations in all were: Argentina, Australia, Austria, Belgium, West Berlin (given full country status), Brazil, Burma, Cambodia, Canada, Ceylon, China (Taiwan), Cuba, Czechoslovakia, Denmark, Dominican Republic, Ecuador, Egypt, Finland, France, Germany (West), Great Britain, Grece, Guatemala, Haiti, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Japan, Kenya, Republic of Korea, Lebanon, Liberia, Luxembourg, Mexico, Morocco, The Netherlands, Nigeria, Norway, Pakistan, Panama, Peru, Puerto Rica, The Philippines, Poland, Portugal, Rhodesia, Siam, Spain, Sweden, Switzerland, Thailand, Tunisia, Turkey, Union of South Africa, United States, Venezuela, and Yugoslavia.

### Wonders of the World

Over 3,000 displays transported the Fair visitor to the faraway corners of the earth. From the intriguing oriental marketplaces to the elegant capitals of Europe, one was thrilled by the strange contrasts of the surge in modern development. From Africa's farthest outposts, the Middle East's ancient cities, the sweeping frontiers of the Americas, nature's marvels were blended with men's unique cultures and ingenuity, to ring a vibrant challenge.

The unique "Chronochime," a charming combination of carillon chimes and clocks especially built for this Fair filled the great building with cheerful tintinnabulations every quarter hour.

The towering structure, keystone of the exhibit of tiny Holland, serenaded visitors with "Dixie," "O Sole Mio," "Piet Hein," and "O Dennenboom," among other tunes. Every quarter of an hour, the "Chronochime" recorded the time.

In addition, the correct time in seven famous cities of the world were shown on separate clock faces in honor of the Fair's international motif. To complete the picture, a parade of colorful human caricatures representing various peoples of the earth rotated around the top edge of the bell tower.

A priceless collection of jewelry confiscated from ex-King Farouk by the Egyptian Government was exhibited.

The collection was the keystone of the Egyptian display which also includes other gold and silver jewelry, brocade, brass and copper work, inlaid boxes and trays, and ivory art objects.

The appearance of the Farouk collection at the Fair was the first display of the unique collection in the United States. It was part of the first allotment released by the Egyptian Government for sale after the confiscation.

### Industrial Exhibits

Fair visitors interested in how writing developed saw beautiful black-and-white and color panels which reproduced such milestone as the famous Phaistos Disc, a terra cotta disc telling a story in little stamps and dies, found in Crete and dating to about 1700 B.C.; ancient Chinese alphabet symbols; Hittite hieroglyphics of about the 9th century B.C., and others.

They formed a striking contrast to such modern machines as the superautomatic Olivetti Tetractys printing calculator, the featherweight portable typewriter Lettera *22*, and other Olivetti writing and figure-work machines.

British firms exhibited on composite

### Future Meetings of Other Societies

**International Geophysical Year,** 10 major physical field co-ordinated investigations, July 1, 1957 through December 1958, U.S. National Committee, IGY, National Academy of Sciences, Washington 25, D. C.

**Nuclear Energy for Industry**

*Nuclear Engineering Short Course,* July 1-August 30, Engineering & Sciences Extension, University of California, Berkeley 4, Calif.

*Nuclear Engineering Survey,* July 8-12, Engineering & Sciences Extension, University of California, Berkeley 4, Calif.

**Physical Problems of Color Television,** UNESCO symposium, July 2-6, Conservatoire des Arts et Metiers, Paris 3e, France

**International Electrotechnical Commission,** July 2-12, Moscow, Russia, U.S.S.R.

**17th Personnel Testing Institute,** July 8-19, Personnel Testing Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y.

**AMA,** summer education program, July 8-August 30, Colgate University, Hamilton, N. Y.

**British Plastics Exhibition,** July 10-20, National Hall & Grand Hall at Olympia, London, England.

**Electronic Data Processing for Business and Industry,** July 22-26, Hotel Roosevelt, New York, N. Y.

**Western Summer Radio-Television & Appliance Market** (Div. West. Home Goods Market) July 22-26, Western Merchandise Mart, San Francisco, Calif.

**Institute of Aeronautical Sciences,** National Naval Aviation Meeting, August 5-10, U. S. Grant Hotel, San Diego, Calif.

**International Scientific Radio Union,** 12th General Assembly, August 18-31, Boulder Laboratories, National Bureau of Standards, Boulder, Colo.

**High Energy Physics Symposium,** sponsored by Oak Ridge National Laboratory and Oak Ridge Institute of Nuclear Studies, August 19-24, Oak Ridge, Tenn.

**Liquid Scintillation Counting,** August 20-22, Technological Institute, Northwestern University, Evanston, Ill.

**Western Electronic Show and Convention,** August 20-23, Cow Palace, San Francisco, Calif.

**International Radio Scientific Union,** 12th General Assembly, August 23-September 4, Boulder, Colo.

**7th International Combustion Symposium,** August 28-September 3, The Royal Institution and Oxford University, London, England

**ASME,** Heat Transfer Conference, August 11-15, Pennsylvania State University, University Park, Pa.

**Management Science and Computer Technology courses,** August 19-30, University of Michigan College of Engineering, Ann Arbor, Mich.

**Computers and Data Processing,** 4th Annual Symposium, August 29-30, Albany Hotel, Denver, Colo.

**Engineering, Marine, Welding, and Nuclear Energy Exhibition,** August 29-September 12, Olympia Hall, London, England

**Peaceful Atomic Energy Uses,** 2nd U. N. Scientific Conference, September 1-13, Geneva, Switzerland

**IUGG,** 11th General Assembly, September 3-14, University of Toronto Campus, Toronto, Ont., Canada

**American Mining Congress,** Metal Mining and Industrial Minerals Convention, September 9-12, Hotels Utah and Newhouse, Salt Lake City, Utah

**3rd Annual Titanium Lecture,** September 9-13, College of Engineering, New York University, New York, N. Y.

stands. Joseph Rodgers and Sons Ltd., of Sheffield, introduced their new range of "hot-bonded" pocket knives.

A sewing machine which performs like a television set was on display at the Japanese exhibits area. It was developed by the Brother International Corporation of Nagoya, Japan. If you can play your television set, then you can make intricate embroidery stitches on this distinguished contribution to the sewing machine invention. It is called the Brother Pacesetter and manufactured with the "wishing dial" which features many stitch variations. The design and principle are so advanced that it is unlike any machine on the market at the present time, it was stated. It is so simple to use that no instruction book is necessary, you simply select the "channel" or design of stitch fancied, and it instantly appears on the fabric. This new type of sewing machine was conceived specifically for the American market, and it is claimed to be the easiest automatic embroidery sewing machine in the world today.

## Fresh Foods at Room Temperature

Two separate processes whereby foods can be stored without refrigeration have been announced recently.

Radar is coming to the aid of the housewife in the kitchen, and fresh foods for men in the front lines may be the routine of the armed forces future feeding program by means of ionizing radiation.

Scientists are using radar's electronic energy, in the first instant, to preserve fresh and cooked foods so they can be stored on a kitchen or grocer's shelf at room temperature indefinitely without refrigeration, at the Raytheon Mfg. Co.'s Food Laboratory.

Still in the laboratory stage, the new process is expected to make available normally perishable meats, fish, fruits and vegetables in unfrozen form the year round without loss of flavor, texture, or nutrient value.

Possible uses for this new technological breakthrough are extensive: The process could be invaluable to the military in their supply problem.

In the medical field, production of freeze dried tissue for tissue banks would be speeded up. This could make large quantities available in a shorter time to meet emergencies caused by disasters.

This advance in food preservation marks a major step forward in the technique of "freeze-drying." Freeze drying is considered by many food scientists as one of the most promising methods of preserving foods since canning and quick freezing.

In the latter report, "Keeping Up," published by Television Shares Management Corporation, tells of the process to be used by the U. S. Army which will also have significance for the food processing industry in distribution to the public.

It is stated that these possibilities stem from a recent announcement of a contract awarded to Varian Associates of Palo Alto, Calif., by the Quartermaster Corps for the construction of an electron linear accelerator at the Army's new food radiation center in Stockton, Calif.

Food packages up to six inches thick will be handled by the Varian accelerator and will contain normally perishable foods such as uncooked pork, chicken, and vegetables. These will be passed through the accelerator beams by a conveyor and may then be stored many months without refrigeration because the device's ionizing radiation destroys bacteria in food.

A program of feeding irradiated food to human volunteers, which has been proceeding over a period of many months, recently received national publicity. Frequent medical examinations of the volunteers have revealed no harmful effects from the irradiated diet.

If this program is successful, the way will be open for approval of the process by the Food and Drug Administration which, in turn, would permit the food processing industry to use radiation processing of fresh foods for the general public.

## Machine Gun Staples Semiconductors

Development of a new "machine-gun" assembly technique was announced recently by Hughes Aircraft Company.

The new manufacturing shortcut substitutes mass production methods for long, laborious handwork in incorporating semiconductors into electronic circuits. As a result, semiconductors will be much more economical to use in electronic assemblies, J. S. O'Flaherty, manager of the company's Semiconductor Division, said.

The "machine-gun" technique, adapted by company engineers, uses long flexible belts of precisely spaced semiconductors that feed into stapling machines on the assembly line. The machines tack the tiny electronic components into place. Formerly, workers had to handle each semiconductor separately.

Several major users of semiconductors recently have adapted their assembly lines to the "machine-gun" method. The company supplies belted semiconductors at no increase in price.

**SHORTCUT for electronics industry has been devised by this assembly-line "machine-gun" which machine staples semiconductors into electronic circuits, eliminating hand assembly.**

Engineers solved two major problems in perfecting the new manufacturing technique. They invented a machine, for which a patent now is pending, that fabricates the belts used in the assembly. They also adapted a stapling machine, manufactured by United Shoe Machinery Corporation of Boston, Mass., to tack the secimonductors into place without damage.

## Beacon Transmitter Built in Standard Size Sardine Can

A completely transistorized UHF beacon transmitter, so small that it has been built inside a standard size sardine can, has been announced by the Electronics Division of Fairchild Controls Corporation, a wholly owned subsidiary of Fairchild Camera and Instruments Corporation.

Using printed circuitry throughout, it is capable of sending radio signals a distance of 25 miles continuously for a period of 24 hours.

Designed primarily for military applications as an emergency signalling and communications device, the "sardine can" transmitter can be modified for voice or code operation at frequencies other than the 280 to 322 mc for which it was designed.

**UHF BEACON TRANSMITTER is actually built into a standard sardine can. Two transistors and a toroidal power transformer make up the power supply. Battery pack is separate unit. Power oscillator (right), two plate condensers, and a tuning condenser are shown.**

A new application of printed or etched circuits was revealed in the tiny tone amplitude modulator and transistorized transmitter power supply. The circuit itself is etched on two copper surfaces which adhere to and are separated by Kel-f laminate, a fluorocarbon of extremely low-loss dielectric material. Selection of this type of insulator is essential with the use of high frequency circuits.

A toroidal type power supply is built into the sardine can. Size of the standard sardine can is 2 3/4 inches by 4 5/16 inches by 1 inch. Cans are stripped of lacquer coating and silver plated before use. When

finished, the can weighs less than 8 ounces.

The output feeds a standard subminiature 50 ohm coaxial cable which is attached to a simple self-erecting quarter-wave antenna radiator.

The antenna is housed in a hermetically sealed tube only 12 inches long, but is exploded into action by a small gunpowder charge. This makes a 2-foot antenna mast surmounted by a 1-foot radial, with six 1-foot ground plane radials projected at a 45 degree angle from the base of the radiator tube.

## Rockets Used To Map North Wind

The U. S. Army is now firing high altitude rockets from the top of the world to map the North Wind near its source, the Department of the Army announced.

The rockets will reveal for the first time the precise direction, speed, and temperature of icy winds responsible for winter cold spells as well as other high altitude winds. These currents of air will be thoroughly explored to an altitude of 80 miles.

The first specially equipped Aerobee rocket has already been fired from Fort Churchill, deep in northern Canada. Nine more launchings will follow during the 1957-58 International Geophysical Year (IGY), the first of which will take place next July.

Like Fourth of July skyrockets, the Aerobees spray 18 packets of high explosives into the air at preset intervals during the ascent. As the four-pound charges explode, sensitive instruments on the ground record the barely audible blasts.

From the time lag between each explosion and the sound's arrival on earth, scientists can compute vital facts about the polar winds. This "grenade" technique, proved at White Sands, N. M., was perfected by physicists of the U. S. Army Signal Engineering Laboratories.

The study is part of the 40-nation IGY program at the Canadian–U. S. proving ground in Manitoba. Results of the tests will be shared among all IGY nations.

The Signal Corps rocket program at Fort Churchill is the second leg of an army world-wide spot-check of high altitude mass currents, which spawn all weather. Extensive observations of western air currents already have been made at White Sands. Another series of IGY–Army launchings is planned at Guam, in the west Pacific.

This huge triangle of observations will allow scientists to reconstruct the world-wide wind pattern to high altitudes never before possible. Knowledge of these winds is important for long range forecasting and for basic understanding of weather.

## Trailer Diesel Plant Meets Highway Size and Weight Limits

The world's most powerful trailer-mounted diesel generating plant rated at 675 kw for continuous, heavy-duty service has been built by Fairbanks, Morse & Co. This complete, self-sufficient plant meets size and weight requirements for over-the-highway movement and produces one-third more power than the previous largest over-the-road generator.

The plant built for the U. S. Navy is 36 feet 2 inches in length, 8 feet in width, and 12 feet 6 inches in height and weighs just 72,000 pounds, less than 107 pounds per kilowatt of capicity. This includes a six cylinder Model *38D8-1/8* opposed-piston diesel rated at 962 hp at 720 rpm, generator, switch-gear and control equipment, complete cooling, lubricating and fuel systems, starting air compressor, and auxiliary engine. The semitrailer even includes a 450-gallon fuel tank, sufficient to run the diesel at full load for nine hours. Thus, when a highway tractor hauls the trailer to the spot where power is needed, it can start delivering 675 kw immediately after it is hooked to the distribution line. Two or more units could function as an integrated plant, quickly providing any required power supply.

The main engine drives a dual voltage 2,400/4,160-volt, three-phase, 60-cycle generator with exciter mounted on top of the generator frame. A switchgear equipment enclosure provides space for mounting equipment to meet customer requirements and there also is space for conductor links for Y or delta connection, line disconnect switches, and transformers to step down voltage for the fan motor, lighting, and auxiliary equipment. A protected terminal board on the back of the switchgear enclosure makes it easy to connect to a distribution line brought through either of two small doors on both sides of the trailer body near the roof line.

## The Argonaut Educational Training Reactor

The Argonaut—the Argonne assembly for university training—a new educational training reactor at Argonne National Laboratory, was the center of attention during an industrial and educational symposium recently held at the Laboratory. The high point of the two-day meeting, attended by representatives of 32 universities and 60 industrial firms, was the demonstration of this low cost "do-it-yourself" reactor. The conceptual design of the Argonaut was developed under the direction of Dr. B. I. Spinrad, associate director of the Laboratory's Reactor Engineering Division; D. H. Lennox, of the same division, served as project engineer.

There were three criteria which guided the design and construction of this reactor: It had to be useful for reactor research and training; it had to be ultrasafe; it could cost no more than $100,000. The Argonaut went critical on February 9, in the midst of the dedication of Argonne's Experimental Boiling Water Reactor (EBWR), the first plant-size power reactor in the nation.

The Argonaut is a low power, low cost reactor of wide flexibility. It was developed primarily for use by students attending the Laboratory's International School of Nuclear Science and Engineering, where courses are taught in reactor theory and nuclear physics. The Argonaut is designed to operate at an intermittent power development of 10 kw. Its safety features and simplicity make it particularly suited for training purposes. The reactor has received the attention of United States educators as well as those from abroad.

A brief ceremony marked the release of the custody of the reactor from the Laboratory's Reactor Engineering Division to the International School, Dr. R. G. Taecker, director.

A technical review of reactor experiments possible with the Argonaut are given in the paragraphs which follow.

Students may participate in observing the behavior of the reactor as fuel is added to it to make it critical. A self-sustaining chain reaction can be achieved with many different shapes of fuel loading and correspondingly different critical masses. The distribution of fissions in the fuel can be studied. Poisons (neutron absorbers) and bubbles, such as may be produced by boiling in a power system, can be introduced and their effects observed.

The reactor can be made to change its power in a number of ways to observe its response to control rod operations and also its response to simulated operating conditions at high power.

The reactor can be used for nondestructive chemical analysis. The activation analysis technique, in which a sample is irradiated in order that the characteristic radioactives of its constitunets may be examined, is one such.

**CHECKING level of a stringer withdrawn from thermal column of Argonaut reactor is Andrew Selep as D. H. Lennox and Albert Cokeing read instruments at control console.**

*Argonne National Lab. Photo*

## Crevasse Detector Developed by Army Engineers

U. S. Army Engineers have developed a device that locates crevasses—camouflaged Arctic "canyons" with enormous appetites for men, equipment, and supplies.

Developed by the Engineer Research and Development Laboratories (ERDL), Fort Belvoir, Va., and the Southwest Research Institute of San Antonio, Texas, the unit creates a low frequency electromagnetic field which is distorted by the presence of a crevasse.

Basically, the device consists of four "electrodes" placed at approximately 20-foot intervals. Its workhorse is a Weasel (an over-snow vehicle) that carries special electronic equipment, moves three electrodes in the form of disk-shaped sleds about four square feet in size, and acts as an electrode itself.

The search-head is pushed ahead of the Weasel. The other sleds are towed behind. The rearmost sleds combine to create the electromagnetic field. Power is provided by a generator carried on the sled initially behind the vehicle.

For practical application, multiple electrodes are provided to produce alternate configurations for optimum detection over varying snow conditions and crevasses. Provisions are also made to power the electrodes from the vehicle.

In operation, the driver keeps a watchful eye on a special recorder as the Weasel moves over the ice. As long as the meter stays steady, it means the terrain is uniform. When the search-head reaches a crevasse, the dielectric difference in the air in the crevasse and the surrounding area causes a noticeable change in the recording. The alarm is distinct when the Weasel is about 10 feet from the danger point. Inasmuch as the vehicle travels only about three to five miles an hour, this is sufficient warning.

The detector located all known crevasses and some new ones during tests covering more than 100 miles of the Greenland Ice Cap last summer. A detector made from Army Engineer drawings was also used with much success by members of the U. S. Navy's Task Force 43 operating in the Antarctic.

## Television Allocations Study Organization Formed

The "Statement of Policies and Operations" of the Television Allocations Study Organization (TASO) is now available to interested individuals or groups. The formation of TASO resulted from a request by the Federal Communications Commission (FCC) in September 1956 to five major elements of the television industry to cooperate in conducting a study program into the technical aspects of uhf and vhf television broadcasting.

Together, the parent organizations of TASO represent every phase of the television industry in this country—vhf and uhf stations, stations in both large and small markets, the educational broadcasters, and the manufacturers. TASO's board of directors is composed of two representatives from each of these organizations. They are:

Association of Maximum Service Telecasters: J. S. Hayes, WTOP-TV, Washington, D.C.; and J. H. DeWitt, Jr., WSM, Nashville, Tenn.

Committee for Competitive Television: J. G. Johnson, WTOB-TV, Winston-Salem, N.C.; and W. L. Putnam, WWLP (TV), Springfield, Mass.

Joint Committee on Educational Television: Ralph Steetle and Dr. Edgar Fuller.

National Association of Radio and Television Broadcasters: H. E. Fellows and T. H. Brown, Jr.

Radio-Electronics-Television Manufacturers Association: W. L. Reynolds and H. E. Bernstein.

Dr. G. R. Town has been retained as executive director of TASO to co-ordinate the work of five technical panels set up to conduct the studies. Dr. Town is on a one-year leave of absence from Iowa State College where he is associate director of the engineering experiment station. He was formerly manager of engineering and research at Stromberg-Carlson and is a Fellow of the AIEE and the IRE.

The chairmen and vice-chairmen of the five technical panels are:

Panel 1—*Transmitting Equipment:* W. J. Morlock (chairman), general manager, Technical Products, General Electric Co., Syracuse, N. Y.; R. N. Harmon (M '52) (vice-chairman), vice president for engineering, Westinghouse Broadcasting Co., New York, N. Y.

Panel 2—*Receiving Equipment:* W. O. Swinyard (chairman), chief engineer, Hazeltine Research, Inc., Chicago, Ill.; K. A. Chittick (vice-chairman), manager, television receiver engineering, Radio Corporation of America, Camden, N. J.

Panel 3—*Field Tests:* Knox McIlwain (chairman), assistant to the vice-president, research and engineering, Burroughs Research Center, Paoli, Pa.; Frank Marx (vice-chairman), vice-president in charge of engineering, American Broadcasting Co., New York, N. Y.

Panel 4—*Propagation Data:* Dr. F. G. Kear (chairman), partner, Kear and Kennedy, Washington, D. C.; S. L. Bailey (vice-chairman), president, Jansky and Bailey, Inc., Washington, D. C.

Panel 5—*Analysis and Theory:* Dr. R. M. Bowie (chairman), director of research, Sylvania Electric Products, Bayside, L. I., N. Y.; W. B. Lodge (vice-chairman), vice-president in charge of engineering, Columbia Broadcasting System Television Division, New York, N. Y.

It is expected that the membership of the panels will soon be announced and, at that time, the names of all members will be sent. It is not intended, however, that the initial lists shall preclude the addition at a later time of any qualified persons. It is the sincere wish of the organization that any representative of a broadcast station of a television manufacturing company, whether or not his employer is a member of one of the parent organizations of TASO, shall notify the group of his interest and capabilities so that TASO may truly represent the industry as a whole. Tentative lists to date already include such representation, and TASO wishes this industry-wide participation to continue. The only qualifications for membership are technical competence, plus the desire and time to serve on the panels. If there are any questions concerning the objectives of TASO inquiries should be addressed to: Television Allocations Study Organization, 808 Warner Bldg., Washington 4, D. C., attention G. R. Town (F '54), executive director.

## Belgian Utilities Nuclear Power Group Formed

Belgium, which supplied most of the free world's uranium during and since World War II, is now making plans aimed at developing that country into one of the leaders in the nuclear energy field.

To accomplish this objective, an over-all plan and timetable has been worked out, and government and industrial groups are working in close harmony. In the electric utility field, 15 companies have joined forces and formed an organization called Syndicat d'Etude des Centrales Atomiques (SYCA). The primary function of SYCA is to prepare their industry for the coming of nuclear power.

The current Belgian timetable calls for one power reactor every three years between 1958 and 1968, and one new power reactor every two years thereafter. Converters of 100,000-kw capacity with a plutonium output of 200 pounds, are expected to be in operation by 1963, a more advanced type converter in 1966, and a true plutonium breeder in 1968.

Belgium's keen interest in plutonium-enriched uranium reactors stems from the large reserves of very high grade uranium ore in the Congo. Whereas ores in the Blind River field of Canada average between 0.1 and 0.2% uranium oxide, much of the Congo ore is 60 to 70% uranium oxide. The result is low processing costs—an all-important factor in development of nuclear energy for the electrical industry.

Another incentive is that a plutonium-enriched U-238 core has a breeding ratio of 1.5 to 2 (150 to 200 kilograms of plutonium are produced while burning 100 kilograms, which leaves a bonus of 50 to 100 kilograms), whereas the U-235 enriched core has a breeding ratio of only 1.1 to 1.2, thus barely replacing itself.

Coupled with these advantages, Belgium will be in an enviable position as a supplier of nuclear fuel to other countries, if efforts to develop a fast plutonium breeder are successful. A unit of this type will produce about twice as much plutonium as it burns, whereas systems based on U-235 conversion will little more than reproduce the fuel they consume.

## Internal Flexible Memory for Digital Computer

Development by Massachusetts Institute of Technology's (MIT) Lincoln Laboratory in Lexington, Mass., of a very high-speed digital computer with both a large memory capacity and considerable flexibility was discussed recently in a series of papers by Lincoln engineers at the Western Joint

Computer Conference, meeting at the Statler Hotel in Los Angeles.

Compared with present day large scale computers such as "Whirlwind," developed at MIT under U. S. Navy sponsorship, this computer, known as *TX-2*, is designed to accommodate an internal memory with a capacity of 260,000 numbers or words—almost 50 times greater than Whirlwind. Any of these quarter million numbers can be stored or recalled from this magnetic-core memory in any desired sequence at a rate of 167,000 per second, the highest speed yet attained in a computer memory of this magnitude.

By using transistors instead of vacuum tubes *TX-2* will be able to perform addition, subtraction, multiplication, and other types of computer operations at several times the maximum rates of speed now prevailing. For example, numbers equivalent to 10 decimal digits (36 binary digits) can be added at a rate of 140,000 per second.

The basic transistor circuits of *TX-2* such as the flipflop (a two position electronic switch) can be operated at a rate better than five million times per second. Other advantages of transistor circuitry include substantial reductions in size and requirements for power.

The *TX-2* will be used primarily for further experimentation and development in the fields of data-processing systems and their applications to automatic and real-time-control problems.

## NSPE Head Hails "No Union" Victory

The president of the National Society of Professional Engineers (NSPE), R. J. Rhinehart stated that "The results of the recent election at the Minneapolis plant of the Minneapolis-Honeywell Regulator Co., in which engineers rejected the attempts of two unions to represent them, is confirmation of the soundness of the policy of the NSPE which has viewed unionism and professionalism as incompatible."

Mr. Rhinehart's comment was contained in a statement from the NSPE on the election conducted by the National Labor Relations Board which resulted in a "no union" vote of 896 vs 304 for United Auto Workers (CIO-AFL) (UAW) and 197 for Engineers & Scientists of America (ESA) (a federation of unions representing engineers and technicians).

In a separate vote, the technicians also rejected the unionization attempts by the same two unions by a "no union" vote of 404 vs 254 UAW and 62 ESA votes.

## Transistor Developed Provides 5-Watt 10-Mc Output

An experimental silicon power transistor, capable of providing an output of 5 watts at 10 mc either as an oscillator or an amplifier, has been developed at Bell Telephone Laboratories under the sponsorship of the Joint Services. Unilateral gain is in excess of 20 db, and a collector efficiency of better than 40% has been achieved.

Details of this development were revealed in a talk at the National Conference of Aeronautical Electronics in Dayton, Ohio.

The unit is a p-n-i-p diffused emitter and base transistor, in which a near-intrinsic or "neutral" layer of silicon separates the collector from the other elements. Introduction of an intrinsic layer to improve the high-frequency performance of transistors was announced by Bell Laboratories in 1954.

Alpha cut-off is about 100 mc per second, and some laboratory samples have provided as much as one watt output as an oscillator at 100 mc per second. Input and output impedances are on the order of 20 ohms and 300 ohms, respectively.

Original design objectives have been met in the laboratory models and development work on this unit is continuing. Steady improvements in the diffusion process, packaging, and other features are expected to result in a transistor which is highly reliable and relatively easy to manufacture.

## Phototypesetting and Photocomposing Machine

A new typesetting machine, called the "Photon" is a combination phototypesetting and photocomposing machine. It will increase versatility and speed of the typesetting, and enables easiest mixing of type faces, sizes, and arrangements.

The Photon consists of three basic units: (1) the typewriter console, which contains a standard electric typewriter, labeled push buttons and lever controls, copy holder, and the "Makeup Eliminator Panel"; (2) a relay rack on the left of the operator, which contains additional controls for special types of composition; and (3) the photographic unit, which is to the rear of the operator.

Widths of columns and depth leading is preset by the push buttons which can make any of 10 selections. Film used in the operation ranges from 3 inches to 8 inches. A matrix disc which contains the fonts of type desired is placed in position and gives the operator a choice of 16 fonts and 12 separate type sizes in each. Although the width of a column is preset, it can be changed to 80 different set widths by controls that are available.

Corrections can be made within a line before it is photographed. All lines are justified regardless of the font typeface or size intermixed in a given line.

A tape input device can also be used in cases where special technical details in the layout call for greater detail than available at the keyboard. This enables the operator to preserve in tape form any setup for a later duplication either on film or paper with or without changes edited into the tape, if these are required.

Photon makes available a never before possible dream—type with complete two-dimensional control. This ability to produce any complete format directly from a keyboard is true composition, and Photon is true photocomposition.

Newspapers, magazines, and direct mail handlers will find that their display advertising costs will be cut using the Photon method because the many little pieces do not have to be handled as individual units to be assembled and properly placed in layout.

Multiple column composition is also possible as well as superimposition where the material being set calls for it, such as the need to rule through the incorrect usage of a verb in an example given in a grammar book, or to cancel out numbers in a problem given in an arithmetic book. Another advantage is the fact that to get perfectly centered lines, you simply type each line of copy and then press the center button.

A motor driven line-eliminator has been developed for use with the machine, which peels off the emulsion of an unwanted line from the film surface. This portion of film does not have to be cut accurately. The two pieces of film (or up to 8 thicknesses) are placed in a precision 1-to-1 Camera, in accurate position and photographed, giving a corrected negative. Placement of the film in the camera, emulsion up or down, determines whether the negative is suitable for offset or photoengraving.

## Solar Energy Converters Ordered for Two Applications

Two orders for full-size solar energy converters—one for a coastal installation and one from a foreign country—have been received by Hoffman Electronics Corporation, it was announced by N. J. Regnier, manager of the company's Semiconductor Equipment Design Section.

The solar energy converters, called "Big Berthas," consist of arrays of silicon solar cells. These cells, manufactured by the Hoffman Semiconductor Division, Evanston, Ill., are tiny wafers of highly purified silicon

**SERIES 200 of the Photon which is a phototypesetting and photocomposing machine. The unit in the picture is equipped with tape perforator and reader. Makeup Eliminator Panel is seen to left of typewriter keyboard, with regular copyboard directly above the typewriter. Cabinet at left holds photographic unit.**

which capture the rays of the sun and convert that energy into electricity.

The coastal installation has been ordered by the U. S. Coast Guard, and will be used for evaluation in operating harbor navigational aids. This converter, a mounting of over 300 solar cells, will supply approximately 13 watts of power. It will be used to power a flashing light, which will be installed at the Los Angeles Harbor lighthouse by Hoffman engineers. The light itself will be hooded to avoid confusion by mariners, but the test is expected to prove the usefulness of solar power in this type of application.

The foreign order, which has been received from the government of the Union of South Africa, is for two converters to be evaluated for use in remote telephone lines in that country.

Both of the orders are expected to be delivered before the end of June.

Hoffman is also presently engaged in a study program for the U. S. Air Force to investigate and survey techniques for the use of solar energy converters.

## Powerful Radio Signals Transmitted from Planet Jupiter

For almost two years a scientist at the Boulder Laboratories (BL) of the National Bureau of Standards (NBS) has been studying radio signals of tremendous power from Jupiter.

To date Astrophysicist Roger Gallet, using data recorded on equipment designed by Dr. K. L. Bowles of the NBS staff, has located five sources of these signals. "Indications are, however," he said, "that there are many more of weaker strength with emissions blended together."

The sources seem to be permanently located and one of the most interesting things about them is that they do not emit on all radio frequencies at once.

Intrigued by the unusual strength of the signals, some observers speculate that they come from mighty thunderstorms on Jupiter. Gallet's work rules out the thunderstorm possibility because lightning discharges, unlike the Jupiter emitters, do broadcast on all frequencies at the some time and have some other very different characteristics.

During the past two years, Gallet has made a very detailed study of the two kinds of pulses—long and short—sent out by the planet. The long pulses can be measured more precisely. They average two seconds in duration and generate 100 thousand times more energy than the total energy of a strong lightning discharge in our atmosphere. On the other hand, the short pulses discovered just a year ago by the BL last, on the average, only about 0.03 seconds and seem to be much more infrequent than the long signals.

Gallet thinks they must have a much different origin than the long pulses. In any case, "the mechanism of both types of emissions remains a real puzzle to astronomers," he said.

Concerning the origin of the signals, Gallet suggests that they may have a shock-wave origin, "perhaps they come from geyser-like phenomena or some sort of volcanic activity, although completely different from any such activity we know on earth, because the material constituting Jupiter is very different from that of Earth."

Astronomers have calculated the mass of the planet to be larger than all of the other solar planets combined and 318 times that of the Earth. With a density only about one fourth that of Earth, it cannot be composed of the same material as Earth. It is probably composed largely of hydrogen—both the atmosphere and the solid body. The clouds themselves are like our cirrus, the long filamentary clouds of high altitude made of crystals of ice; however, in Jupiter's atmosphere, the ice is not of water, but of ammonia. Also, a relatively large amount of the gas methane exists in Jupiter's atmosphere.

Using telescopes, astronomers are limited to observations of the top of Jupiter's cloud atmosphere. They have found that markings in the atmosphere vary in rotation time at different latitudes. Quite mysteriously the equatorial band turns in five minutes less time than the rest of the planet's atmosphere markings. Therefore, the astronomers are unable to determine a uniform rotation time for the planet.

Gallet does not have these particular troubles. By using the emission centers as reference points, he has determined the rotation of the solid body beneath the clouds to within an accuracy of some tenths of a second—9 hours, 55 minutes, and 30 seconds.

The Great Red Spot of Jupiter approximately 22,000 by 7,000 miles in size is another mystery. Astronomy writers have often described it as a gigantic eruption, but only on extremely flimsy evidence. No one actually knows what it is. Last year it happened to be at about the same longitude as the strongest radio emission source and anyone less cautious than Gallet might have been led to conclude that the Red Spot is an extremely active radio emissions center.

But with evidence collected this year, he has shown that it only happened to coincide with an emitter and is now 80 degrees away from it.

Perhaps the most important evidence on Jupiter which Gallet has compiled is that which proves the huge planet has a strongly ionized upper atmosphere—an ionosphere—similar to our own. Like our ionosphere, its electronic density increases and decreases in relation to the amount of ultraviolet radiation from the sun.

Gallet has found that the emissions from each source, recorded at a specific frequency, come through a cone of transmission radiating out from the source. This indicates to him that the radio waves within the cone are penetrating Jupiter's ionosphere, but the oblique waves outside the cone are reflected back to Jupiter by its ionosphere. In other words, it is these limitations on the penetration of the signals that proves the existence of an ionized upper atmosphere of Jupiter.

Further proof for a Jupiter ionosphere is found in the fact that the cone is larger for 20 than 18 mc, which are the two frequencies on which the BL observations are conducted simultaneously.

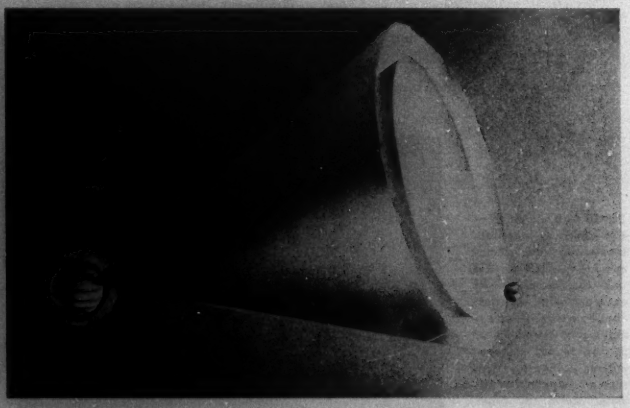
When the sun is particularly active, such as now during peak sunspot activity, our ionosphere contains too much ionization to allow many radio waves to pass through it. This limits the observations to a short span of months. This year the observations were possible only from November 1956 to March 1957.

Interestingly enough, this radio astronomy work also must be done at night when our ionosphere is less ionized and the Jupiter waves can come through.

Gallet has found that the cones of radio waves coming from Jupiter have smaller angles this year than last because the increased solar activity has increased the ionization in Jupiter's ionosphere.

Gallet and other astrophysicists feel that they have only begun to fathom the mysteries of Jupiter. Future studies will lead to more information about the characteristics of the radio pulses. Plans are being made to use the radio emissions to measure the strength of the planet's magnetic field. Such a step is very important in determining the inside structure of the planet.

The receiving antennas which direct radio signals originating 500 million miles from Earth to the complicated equipment for the Jupiter observations are situated nine miles from the BL on a flat stretch of land where there is low interference. Recording equipment is housed in a trailer.



**IDEALIZED DRAWING** illustrates how very high frequency radio signals which are emitted from the planet Jupiter are confined to a beam by the planet's ionosphere.

## Armored Cable Ladder Racks Feed Electric Power

Electric power is fed by interlocked armored cable in ladder racks, developed and manufactured by the General Electric Company, Construction Materials Division, Bridgeport, Conn., to the various components of the new 10- by 10-foot supersonic wind tunnel of the National Advisory Committee for Aeronautics. The wind tunnel is located at the Lewis Flight Propulsion Laboratory situated in Cleveland, Ohio.

The new Lewis supersonic wind tunnel's peak electric power requirements are roughly equivalent to the residential needs of a city with a population of 650,000 persons.

This great concentration of electric load has necessitated the development and manufacture of tailor-made equipment. The new designing was needed to supply and control the power without greatly inconveniencing other users of electric power in the area.

Because of the tremendously great amounts of electric power which are required for this installation, the Propulsion Laboratory's wind tunnel for supersonic flight tests will be operated, for the most part, at night, when off-peak load conditions are prevalent.

## Edison Laboratory National Monument Opened

Edison Laboratory National Monument, Orange, N. J., is one of the truly significant historic places of America. Here still stand the original buildings which Thomas Alva Edison erected in the summer of 1887 to prove his conviction that industrial or inventive research should be carried on by an organized group or team, working together in a laboratory properly equipped for the speedy, systematic solution of problems involved. On this ground, Edison and his co-workers spent 44 years creating those numerous inventions and technical improvements which have made life easier and better for millions of their fellow men. Thus was established a prototype for the many great industrial laboratories that today serve the people, not only of the United States, but of the entire world.

The monument embraces a three-story building containing the inventor's machine shop and stockroom, and a library with 10,000 volumes which he used as an office. There are 4 smaller laboratory buildings and an underground vault as well. A full-scale reproduction of the "Black Maria," the world's first motion picture studio, which Edison built in 1893 soon after his invention of the motion picture camera, stands not far from the original site. This building now serves as a theater where visitors may see both old and present-day films.

Among the countless interesting objects on display at the Monument are the first phonograph ever made; early motion picture equipment; various types of incandescent and "Edison Effect" lamps, the latter illustrating Edison's discovery of a scientific phenomenon which is the basis of modern electronics; the cot in the library where the inventor took "cat naps" while working around the clock; his desk, the contents of which have remained undisturbed since his death on October 18, 1931; and a comprehensive exhibit, originally prepared for the 1933 Chicago World's Fair, telling the story of Edison's outstanding career and his many notable contributions to the fields of science, technology, and industry. The inventor's chemical laboratory remains as it was during the period of his tireless work with 17,000 plants, a project started when he was 80 years old, to discover a commercially useful, domestic source of rubber. Here he again demonstrated the need for constant, careful, and unending experimental research.

In the underground archival vault built in 1940 are Edison's laboratory records, carefully preserved, dating from 1878 to 1931, including 3,400 notebooks, 1,093 United States patents on his inventions, and correspondence from all periods of his life (about 250,000 letters, memoranda, and other records). Here is also stored a large collection of early phonograph records and some 6,000 objects ranging in size from a dynamo to a light bulb filament.

## Atomic Energy Commission Statements and Developments

*Statement by L. L. Strauss, AEC Chairman.* The report issued by the technical staff of the European Atomic Energy Community (Euratom) proposing a target of 15-million kw installed nuclear electrical capacity in the six Euratom nations by the end of 1967 is an encouraging development which marks another step forward in international co-operation to promote the peaceful uses of atomic energy.

The report points out that attainment of the goal fixed for 1967 is essential not only to Europe's economic well-being but also to its political security.

As was stated by the Department of State and the Atomic Energy Commission (AEC) in February 1957, at the time of the visit to the United States of three "Wise Men" of Euratom, it is this country's purpose to help the community of six European countries in attaining their objectives, including both technical and material assistance.

I was pleased to note that the Euratom report describes the partnership of United States industry and Government, in developing the peaceful applications of atomic energy, as having provided this country with "the most complete nuclear foundation in the world."

As stated in the report, both the United States and the Euratom nations will benefit, in terms of more expeditious and sounder development of nuclear power technology, as a result of the co-operative experience to be gained from the designing, building, and fueling of Euratom's nuclear power plants.

*Scientists and Engineers To Get Work Experience.* The AEC has enlarged its program under which privately employed nuclear scientists and engineers may obtain specialized work experience in AEC laboratories and plants as an aid in the further development and use of atomic energy for peaceful purposes.

The program will be administered by AEC field offices, assisted by the AEC's Division of Civilian Application. Its primary purpose is to help people already generally educated and trained in nuclear science and technology to become familiar with specific uses; it is not intended as a program offering basic training.

The work experience program recognizes (1) that scientists are engineers qualified through training and experience to apply nuclear technology directly to specific projects are necessary to expansion of peaceful applications and to increased industrial participation and (2) that until a diversified private industry is developed the necessary training and experience often can be obtained only in AEC facilities.

Firms and organizations interested in the program should address their inquiries to the Field Operations Office of the AEC having jurisdiction over the facility in which work experience is sought. Inquiry may be made, too, of the Director, Division of Civilian Application, Atomic Energy Commission, Washington, D. C. Applications will be considered on the basis of (1) whether the knowledge and training desired are available outside any of the AEC's facilities; (2) whether the employees to be assigned appear to be qualified to take full advantage of the work experience, and (3) whether the assignments can be arranged without undue burden on the regular work of the particular AEC facility.

*New Type Atom Smasher.* A new type atom smasher, a linear accelerator designed for the study of the elements and isotopes in the transuranic region, including an attempt to synthesize atoms heavier than element 101, has gone into operation in the University of California (U of C) Radiation Laboratory, it was announced jointly by the AEC and the U of C, Berkeley.

The machine, called the HILAC, is now accelerating nuclei of nitrogen atoms (Nitrogen 14) to energies of 140 million electron volts.

The new instrument does not compete in energy with such ultrapowerful machines as the Radiation Laboratory's Bevatron, which accelerates protons, the nuclei of the lightest element, hydrogen, to 6.2 billion electron volts.

In contrast, the new atom smasher is designed especially to accelerate the nuclei, or ions, of very heavy atoms. It is therefore called a heavy ion linear accelerator, or HILAC. The HILAC may permit the synthesis of elements heavier than Mendelevium (element 101), the heaviest now known. Elements heavier than uranium, element 92, are all synthetic, and are obtained by transmuting uranium nuclei, step by step, into successively heavier atoms.

*American Republics Participate in Nuclear Energy Symposium.* An Inter-American Symposium on the Peaceful Applications of Nuclear Energy was held May 13-17, 1957, at Brookhaven National Laboratory, Upton, N. Y. The Symposium agenda was designed to stimulate efforts among the 21 American Republics to develop and utilize the beneficial applications of nuclear energy. The Symposium was conducted by the Brookhaven National Laboratory and jointly sponsored by the AEC, the Department of State, and the International Co-operation Administration.

Groundwork for the Symposium was laid in the Fall of 1957 by Dr. Milton Eisenhower at a meeting of the Inter-American

Committee of Presidential Representatives in which the 21 American Republics that compose the Organization of American States participated. These are: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, United States, and Venezuela.

Approximately 100 Latin American leaders in the field of nuclear energy were invited to participate, in addition to a representative group of United States scientists who are specialists in various aspects of the civilian nuclear energy program.

The primary purpose of this bilingual Symposium was to explore present and future uses of atomic energy in the Americas. Special attention will be given to practical efforts to accelerate development of atomic energy programs that will embrace useful research and seek applications that are economically and industrially valuable. Proceedings will be published in full.

## Weight and Center of Gravity Calculated in Second for Aircraft

Portable scales which weigh an airplane and automatically determine its center of gravity have been developed by the Air Research and Development Command (ARDC). At present, aircraft must be weighed on permanent scales within a hangar, and the center of gravity calculated manually.

Finding the center of gravity is necessary in loading an airplane in order to insure correct balance of the plane during flight. With the new scales, a constant check on the center of gravity can be maintained as the aircraft is loaded.

Brig. Gen. T. L. Bryan, Jr., commander of ARDC's Wright Air Development Center, explained that the new system permits the U. S. Air Force to weigh an aircraft on the flight line and calculate more accurately its weight and center of gravity within a few seconds. Manual calculations require several hours.

One portable scale is placed beneath each wheel of the airplane and electronic load cells measure the amount of compression created. This data is transmitted to the computer in the form of electronic impulses, which simultaneously determine the weight of the aircraft and its center of gravity.

## International Scientific Conference Planned by UNESCO

More than 1,000 scientists are expected to attend a huge international conference to be convened by UNESCO in Paris, France, in September 1957 to discuss the use of radioisotopes in research. The conference will be strictly scientific in nature, devoted to the presentation and discussion of original papers on scientific research. It will not be empowered to adopt resolutions or make recommendations. It is held in conformance with the Director-General's mandate from UNESCO's General Conference to " . . . assist scientific collaboration in connection with the peaceful utilization of atomic energy."

In his letter to Member States, Director-General L. H. Evans points out that developments in atomic energy during the past few years have made it possible to produce a large number of radioisotopes which are being used for research in biology, physiology, agriculture, medicine, oceanography, and industrial research. Plenary sessions of the meeting will be devoted to new developments in measuring techniques and significant advances in the production of radioisotopes.

## New Nuclear Fuel for Use in Power Reactors

Scientists at the Argonne National Laboratory, Lamont, Ill., have developed a new type fuel potentially useful in nuclear power reactors.

For the first time, Argonne is using ceramic pellets of urania-thoria ($UO_2$ and $ThO_2$) fuel constituents to produce heat for electricity from a nuclear reactor.

The development work was done at the Laboratory's main site at Lamont. The pellets are now being used in a BORAX series experimental reactor at Argonne's branch at the National Reactor Testing Station site near Idaho Falls, Idaho.

The core is composed of oxides of thorium and uranium. Both thorium oxide and uranium oxide have been used in ceramics for many years, but the use of thorium and uranium oxides as nuclear fuels has not been tried before.

One of the major reasons for the use of ceramics as fuel elements in a reactor is that they do not, like metallic fuel elements, grow and become distorted under intense irradiation. Under some conditions, metallic fuel elements have been known to double in length. Due to the airtightness demanded of reactors to hold in radioactivity and because of possible mechanical failure, such physical changes can be dangerous. Ceramic fuel elements offer a way to prevent many of the problems due to metallic growth under fission.

The ceramic specimens prepared were tested both with and without an outside protective metal covering. Aluminum nickel alloy, stainless steel and zircaloy-II coverings were used on some specimens. Some of each kind of covered and uncovered ceramic elements were put in water or in sodium-potassium (NaK) liquid metal and irradiated. The various fuel elements showed good resistance to corrosion in either water or NaK. (Corrosion resistance is an important factor in any material put inside a nuclear reactor.)

The results of the tests indicated that a ceramic core consisting of a mixture of uranium oxide and thorium oxide pellets, when sintered (fused) together and assembled in an aluminum high nickel covering will furnish a suitable material to be placed in a nuclear reactor.

The reactor for which the ceramic fuel was designed is the BORAX-IV reactor, operated by the Argonne National Laboratory at its Idaho branch, a modification of the famous BORAX-II reactor which lighted the town of Arco, Idaho, during the night of July 17, 1955.

Some of the major advantages of ceramic fuels for reactors may prove to be: (1) ceramics will withstand high temperatures, (2) ceramics are highly resistant to corrosion in water, and (3) ceramic fuel elements "grow" comparatively little under irradiation.

# LETTERS TO THE EDITOR

**INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy and inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.**

## Neutralizing Transformers

*To the Editor:*

I have read the digest of Paper 56-929, entitled "Multiunit Neutralizing Transformers," by T. F. Palmquist, in the March 1957 issue of *Electrical Engineering*, page 201. Multiunit, or multicircuit, neutralizing transformers, of similar basic design and for the same kind of service as described in the article, have been in operation for over 30 years as indicated by these references:

1. A letter to the Editor, *Electrical Engineering*, January 1936, page 121, by the writer.
2. A letter to the Editor, same issue and page, by E. E. George.
3. There is further reference to neutralizing transformers, in a letter to the Editor, *Electrical Engineering*, May 1936, page 561, by R. K. Honaman.

The letters mentioned will disclose further references.

My original installation of multicircuit neutralizing transformers completed on July 1st, 1926, in three hydroelectric plants, two of which were designed for remote supervisory control from the third plant, comprised one transformer with 24 pairs of primary wires and two with 14 pairs of primary wires each. These were designed to neutralize 4,500 volts at 60 cycles. Many subsequent designs were much larger and nearly all were capable of neutralizing 5,000 volts.

Originally I thought of having the cable for the winding built around a central wire which would function as a primary winding, then it was realized that there was sufficient space between the turns of cable to accommodate a primary wire of size 6 or 8. The primary wire and secondary cable windings were therefore wound in parallel, resulting in a coupling so close that I regarded magnetic leakage negligible if excitation remained within design limitation.

All designs utilized stepped cores so that the minimum turn radius slightly exceeded half the width of a full width core sheet. When the required number of circuits is too great for a single winding, a core type design will accommodate two windings connected in parallel. This costs less than two transformers and occupies less space.

Yours very truly,

R. W. OSBORNE (A '18, M '31)

(Retired, Toronto, Ont., Canada)

## Job Opinions

*To the Editor:*

A thorough review of the article entitled "Job Opinions of Engineering Seniors," M. S. Oldacre, J. D. Ryder, and S. R. Warren, Jr., and of the study on which it is based (Ref. 3 of the article) seems to indicate that the statements about teachers' salaries (p. 274 and Fig. 7) are misleading. It is not true that "the data in the (original) report are contradictory to the popular conception." The most valuable data are contained in the table on p. 59 of the *original* report. They show that only seven seniors considered teaching positions, and that their average monthly salary was $386. There were, in addition, included in the "average," given by the authors, 13 graduate students (receiving M.S. degrees) at an average salary of $441, as well as 5 graduate students (receiving doctor's degrees) at an average salary of $591. It is difficult to understand why the analyst should have averaged the data for students with such different levels of education. Inasmuch as the paper referred to "seniors," it should have been well to list the block "Teaching" in Fig. 7 where it rightly belongs; namely, at the bottom with the figure of $386. Everyone familiar with the level of starting salaries for engineers as they prevailed in June 1956 will also know that all three figures ($386, $441 and $591) were much lower than the all employment averages in these three class (B.S., M.S., and Ph.D.) of academic degrees.

Very truly yours,

E. T. B. GROSS (F '48)

(Consulting Engineer)

## First Electrical Earth

*To the Editor:*

We glean from Benjamin Franklin's first description of his lightning conductor system published in 1753 that the wire conducting line was simply inserted in the earth.

It was Sir William Watson, however, who first stressed the value of a good earth contact in connection with electrical experiments and practical applications, although he did give himself credit for theories in connection with electricity which were, in fact, those of Franklin in the first place.

In 1757, he tried a kite flying test in June to prove beyond doubt that lightning was really electric fluid. To form the earth contact, he drove a square iron bar three feet into the ground and then cutting a bottle in two pieces by a silken cord saw he fitted its neck down over the bar head friction tight and placed a bung of soft cotton tree wood in the body of the bottle where it was cut off. Through a small hole in this bung, a brass wire was inserted to connect with the kite string and to extend down to about one eighth of an inch from the top of the bar. During the thunderstorm, sparks were seen jumping the gap with blinding brilliance.

When Sir William fixed a lightning conductor on his house at Payneshill in 1762, he had the conductor wire fixed in perfect electrical contact to a driven iron bar earthed by a hot ferrule ring of wrought iron hammered down over wire and bar. When this contracted, the continuity was considered by Sir William to be according to his theory of good earthing. This was the first mechanical and electrical earth on record.

C. J. ROBB

(Historian)

# NEW BOOKS

**The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.**

THE HISTORY OF ELECTRIC WIRING. By John Mellanby. Macdonald & Co., Ltd., London, England, 1957. 244 pages, 5¾ by 8¾ inches, bound. 32s, 6d. This book gives a general review from 1870 to 1954 of contemporary ideas on wiring. Following the general review, there are nine chapters dealing with such specific items as cables, conduits, switches, plugs, and sockets, with details of their development and of the firms and individuals involved. An extensive bibliography is included. The author is a consultant and practicing engineer of many years experience.

INDUSTRIAL ELECTRONICS HANDBOOK. By R. Kretzmann. Philips Technical Library, Eindhoven, Holland, second edition, 1956. 298 pages, 5⅞ by 9 inches, bound. $6.50 postpaid. An introduction and guide to that branch of electronics concerned with the principles of vacuum and gas-filled electronic tubes, their basic circuits and industrial applications. The new edition has a detailed description of the *E1T* decade counter tube, circuits equipped with this tube, and their applications. There is also detailed information on the design of industrial rectifier circuits including controlled rectifiers, on electronically controlled Ward-Leonard systems (motor control), and on special electronic apparatus, i.e., electronic stabilization of direct current and alternating current, ultrasonic soldering iron, photoelectric revolution counter, low-power two-phase inverter, and electric dust precipitators.

AN INTRODUCTION TO SEMICONDUCTORS. By W. C. Dunlap, Jr. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1957. 417 pages, 5⅞ by 9¼ inches, bound. $11.75. A concise volume on the subject designed for engineers, technicians, and research workers entering the field. Subjects covered include: crystals and their structure and imperfections, statistical mechanics for metals and semiconductors, electron theory of metals and semiconductors, p-n junctions, properties of the elemental semiconductors, semiconducting compounds, rectifiers, transistors, photocells, thermistors, Hall effect, and other semiconductor applications.

INVENTORS AND INVENTIONS. By C. D. Tuska. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1957. 174 pages, 6 by 9¼ inches, bound. $3.75. This manual for present and potential inventors includes: the inventions of primitive man; the relation of environment, education, age, sex, methods, and psychology to invention; patentable inventions; and the marketing of inventions. Some outstanding inventions are covered by the case-study approach. A few patents cases and decisions are presented in an appendix.

LOCOMOTIVE CYCLOPEDIA OF AMERICAN PRACTICE. Published by Simmons-Boardman Publishing Corporation, 30 Church St., New York 7, N.Y., 15th edition, 1956. 728 pages, 8¾ by 11¾ inches, bound. $12. The 15th edition is devoted primarily to diesel-electric locomotives with some coverage of electric and turbine-electric locomotives. The coverage of steam locomotives is limited to a small section. The dictionary has been revised to include only terms relating to the first three types of motive power. The major components such as engines, fuel, lubricating, and cooling systems, and brakes, are covered and also maintenance facilities. An entirely new section on electrical fundamentals has been added.

MODERN PULP AND PAPER MAKING. Third edition revised and edited by J. P. Calkin. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 1957. 549 pages, 6 by 9¾ inches, bound. $10. A revision of the previous editions by G. S. Witham, this third edition has been rewritten by authorities in the field. Full coverage is given to such subjects as: papermaking materials and processes, varieties of paper and paperboard, the sulfite process, the alkaline processes, pulp bleaching, the machine and finishing rooms, paper defects, testing of paper and paper materials, process instrumentation for the pulp and paper industry. References are included.

NUCLEAR REACTORS FOR RESEARCH. Edited by C. K. Beck. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1957. 267 pages, 6¼ by 9¼ inches, bound. $8.50. In this third volume in "The Geneva Series on the Peaceful Uses of Atomic Energy," Part I contains the following sections: the kinds of institutions that may wish to build and install a research reactor, and their fields of research; technological factors affecting choice; performance data, safety considerations, and the uses of research reactors in physics, chemistry, engineering, and biology. Part II describes research reactor projects of all types now in operation at specific locations in Europe and America, including the U.S.S.R. The book provides a list of the papers relevant to research reactors presented at the 1955 Geneva Conference, a subject index, and a name index.

PRACTICAL ELECTRICAL WIRING. By H. P. Richter. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., fifth edition, 1956. 602 pages, 5¾ by 8¼ inches, bound. $5.25. Includes the fundamentals of electrical work; basic principles, terminology, and actual wiring procedures for residences, farms, and nonresidential projects such as schools and churches. All material is based on the 1956 National Electric Code. Modern trends in wiring are emphasized, and full information is given on stand-by generating plants for emergencies.

### Library Services

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# TECHNICAL LITERATURE

**The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.**

**THE PROSPECTS OF NUCLEAR POWER AND TECHNOLOGY.** By Gerald Wendt. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1957. 348 pages, 5¾ by 8¼ inches, bound. $6. A nontechnical report on the present status of nuclear fission, and an appraisal of the future of our society in a nuclear age. Part I gives a comprehensive picture of actual and future atomic energy plants here and abroad, the legal and economic factors involved, and the social consequences. Part II covers the technology of the nuclear industries and the problems which have arisen. The processing, extraction, and disposal of fission products, and future propects are discussed in this part.

**RECENT ADVANCES IN SCIENCE.** (Physics and Applied Mathematics) Edited by M. H. Shamos and G. M. Murphy. New York University Press, New York, N.Y., 1956. (Distributed by Interscience Publishers, 250 Fifth Ave., New York 1, N.Y.) 384 pages, 6 by 9¼ inches, bound. $7.50. Twelve lectures, by acknowledged experts, designed to convey to nonspecialists the basic ideas in such areas of science as cryogenics, ferromagnetism, microwave spectroscopy, operations research, and transistor physics. The lectures were delivered at a symposium held at New York University in 1954.

**STATISTICAL METHODS IN QUALITY CONTROL.** By D. J. Cowden. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1957. 727 pages, 6 by 9¼ inches, bound. $12. The first 12 chapters are mainly on statistical methods with illustrations from the field of quality control. The subjects covered include: statistical data, elementary principles of probability, binomial and multinomial distributions; normal distribution, and analysis of variance. Chapters 13 through 29 are concerned mainly with process control including specification limits and tolerances, use of control charts for variables, and for non-normal distributions, selected techniques for analysis of defectives and the Poisson distribution. Chapter 29, dealing with the economics of control charts contains some original methodology. Chapters 30 through 40 deal mainly with product control containing such subjects as hypergeometric distribution, single, double, and sequential sampling, and analysis of the pattern of variability.

**SYMPOSIUM ON CORONA.** Held by ASTM Committee D-9, Cincinnati, Ohio, November 1955. Published 1957 as Special Technical Publication *No. 198* by the American Society for Testing Materials (ASTM), 1916 Race St., Philadelphia 3, Pa. 32 pages, 6 by 9 inches, paper. $1.25; to members $1.00. Six papers review the test methods used for corona detection and evaluate the results of these methods. The papers are: Preliminary Corona Resistance Test Results from International Electrotechnical Commission (IEC) Activities; Effects of Corona on Plastic Laminates; Corona Resistance Test Method for Laminates, Molded, and Cast Materials; Preliminary Investigation of Proposed Pulse Method for Measuring Ionization; Corona Detection and Measurement at 60 Cycles; and Test Methods for Measuring Energy in a Gas Discharge.

**SYMPOSIUM ON MINIMUM PROPERTY VALUES OF ELECTRICAL INSULATING MATERIALS.** (Special Technical Publication *No. 188*) Published 1957 by The American Society for Testing Materials, 1916 Race St., Philadelphia, Pa. 48 pages, 6 by 8¾ inches, paper. $1.75. Contains seven papers and discussions which include: significance of minimum property values of electrical insulating materials, variability of dielectric breakdown in sheet insulation, establishment of minimum quality levels of sheet insulation, low-temperature resistance test methods for nonrigid insulation, statistical treatment of heat-aging studies on varnished glass cloth.

**TRANSMISSION CIRCUITS.** By E. M. Williams and J. B. Woodford. Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1957. 156 pages, 6¼ by 9¼ inches, bound. $4.25. A text for a one-semester course for senior students majoring in electrical engineering. With respect to transmission circuits or lines, the chapters deal with theory, determination of line parameters, and transients; also power transmission lines in the steady-state, signal lines, high-frequency lines, and lumped-constant transmission networks. Many of the problems are derived from recent developments in the field.

**REPORT OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL UNITS AND MEASUREMENTS (ICRU), 1956.** National Bureau of Standards Handbook *62*, issued April 10, 1957, 48 pages, 40¢. (Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.) This publication covers the recommendations of ICRU as agreed upon at its meetings in Geneva, Switzerland, in April 1956, and replaces its earlier report issued in 1953. The new report includes an extensive amount of basic information necessary to make radiation dose measurements in energy units *(rads)*, and to convert data expressed in roentgens to the equivalent in energy units. It is anticipated that translations of this report will be made into other languages. The first of the four chapters into which Handbook *62* is divided contains an enlarged discussion on radiological quantities, units, and symbols. This includes some pertinent considerations with regard to the parameters involved in the various definitions. In Chapter II, guidance is provided for the clinical application of absorbed dose measurements, giving examples of how the measurements may be used in practical applications. Chapter III presents a detailed treatment of the physical aspects of absorbed dose determination. This covers methods of calculating absorbed dose from measured ionization; the necessary physical data are provided in the form of curves or tables. There is also a discussion of the problem of dosimetry accuracy in X- and gamma-ray therapy. Reports of the subcommittees are given in the final chapter. The results of several recent international comparison relating to both X rays and radioactivity are described. Chapter IV also lists the primary standards, X-ray standards, and radioactivity standards available in various countries and laboratories, as well as an extensive bibliography covering much of the subject matter contained in the report. A suggested outline of an international treatment summary form is given in one of the appendixes. Foreign remittances must be in U. S. exchange and should include an additional **25%** of the publication price to cover mailing costs.

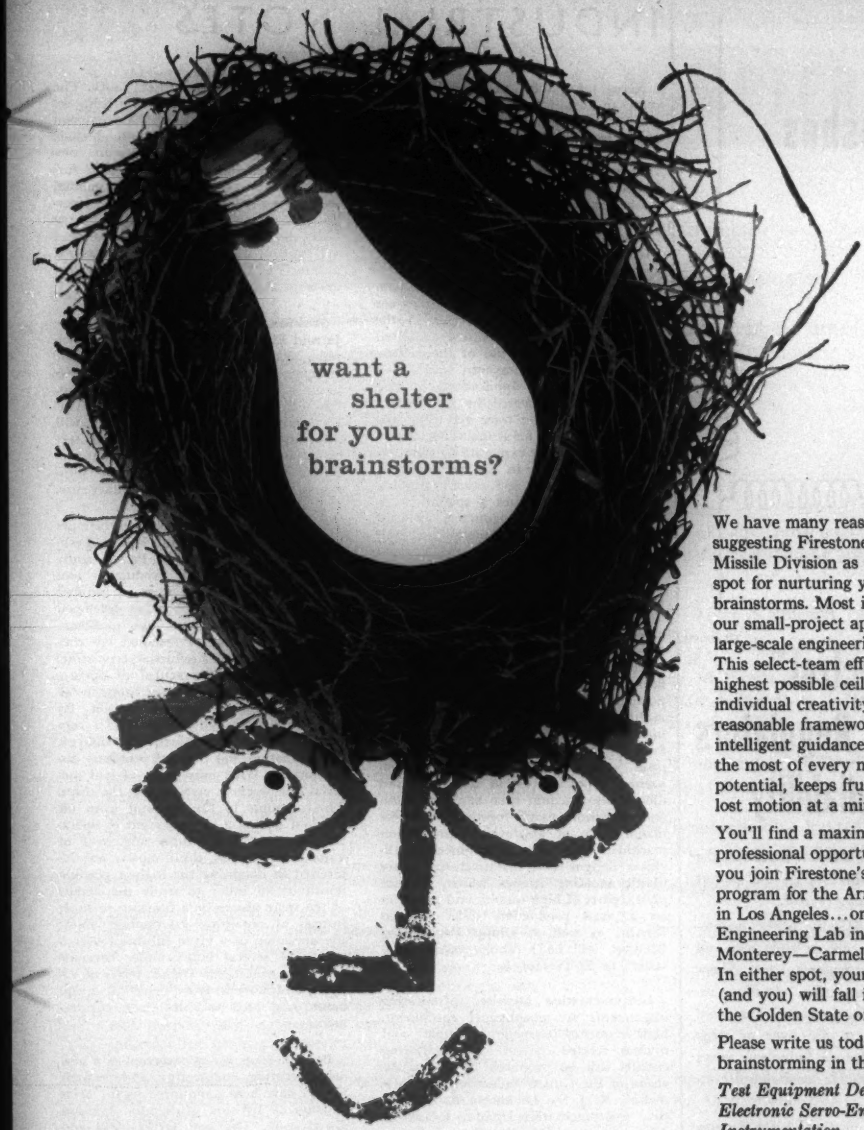
**RADIOLOGICAL HEALTH HANDBOOK.** A radiological health handbook porduced for use in training courses at the U. S. Public Health Service's Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio, is available to the public through the Office of Technical Services (OTS), U. S. Department of Commerce. The 356-page publication contains a glossary of radiological terms and sections on physical, chemical, and mathematical data, radioisotopes, decay, radioassay, and radiation protection. A table of isotopes also is included. The volume, *PB 121784*, S. Kinsman and others, Robert A. Taft Sanitary Engineering Center, Public Health Service, U. S. Department of Health, Education, and Welfare, January 1957, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C., price $3.75.

**ELECTRONICS INDUSTRY FACT BOOK.** The electronics industry established a new record during 1956, Radio-Electronics-Television Manufacturers Association (RETMA) revealed in issuing its third annual "Electronics Industry Fact Book." Factory sales of radios, television, phonographs, military and industrial equipment, and components were $5.9 billion. When distribution, servicing, and broadcasting revenues are added, the "Fact Book" states, the industry value totals $11.6 billion—twice the value of the billings in 1950 but only half that anticipated by 1965. In announcing the compilation and publication of the 1957 edition of the statistical series on the electronics industry, Executive Vice-President J. D. Secrest stated that the data was gathered from a variety of governmental sources by the RETMA marketing data department in combination with presently available RETMA industry figures. The booklet contains a detailed and comprehensive statistical analysis of the size and composition of the radio, television, and electronics industry, including production and sales figures; television picture and receiving tube statistics; and special chapters devoted to military and industrial electronics, tubes and parts, and export data on the industry. Copies of the "Fact Book" are available to non-RETMA members and the general public for 50¢ a copy from RETMA headquarters, 1721 DeSales St., N.W., Washington 6, D. C.

**ASTM STANDARDS ON PLASTICS.** This compilation of American Society for Testing Materials (ASTM) Standards on Plastics contains 40 specifications, 93 methods of tests, 19 recommended practices, and 5 definitions. Of these, 34 are new or revised. Most of the standards contained were prepared under the jurisdiction of Committee D-20 on Plastics. However, certain of the standards were in the field of electrical insulation and are the work of Committee D-9. Among the topics covered are the mechanical, thermal, optical, and performance properties of plastics. In addition, standards for molding compounds, standard shapes, and molds are included. Analytical methods, compounding and electrical tests specifications for plastics are also to be found in this compilation. The Appendix contains two proposed standards presented for information. This volume should be of interest to plastics engineers, chemists, and electrical engineers concerned with insulating problems. Copies of this 871-page book may be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. at $6 each.

**ADDENDUM TO RADIATION HANDBOOK 60.** In a recent statement, the National Committee on Radiation Protection and Measurement (NCRP) presented in brief form its new recommendations on maximum permissible radiation levels, a revision of those contained in National Bureau of Standards (NBS) Handbook 59, "Permissible Dose from External Sources of Ionizing Radiation." The introduction of these new working levels makes necessary the revision of some of the Committee's other recommendations, which are also published in the NBS Handbook series. These deal with various phases of radiation protection such as monitoring methods, waste disposal, safe handling of isotopes, and radiation legislation. Until detailed revisions can be completed, corrective statements are being prepared for each of the handbooks, including the changes needed to comply with the new maximum permissible levels. The first such statement, for Handbook *60*, "X-ray Protection," has been completed. Holders of Handbook 60 may obtain copies of this addendum on request to the National Bureau of Standards, Editorial and Printing Section, Washington 25, D. C.

**NONDESTRUCTIVE TEST METHODS.** The Atomic Energy Commission (AEC) has recently released vital testing information to industry. At a Chicago, Ill., meeting April 16-18, attended by 300 engineers and scientists working in nuclear power development, the results of 15 years' research on nondestructive test methods were revealed. These tests have been found to be necessary because of the critical operational characteristics of nuclear reactors. These tests are primarily designed to detect material defects. Careful analysis of the test results by AEC engineers has resulted in great improvements in reactor material quality and fabrication methods. Not only is this information of importance to the nuclear industry, but is of benefit to the manufacturer of many consumer items, such as refrigerators, air conditioners, temperature controls, etc. Using some of the nondestructive test methods revealed will permit them to find flaws in such materials as tubing and thin sheets where ordinary inspection might pass the item only to have a failure occur in service. The aircraft industry by using similar nondestructive test methods has been able to design structural aircraft frames using considerably higher unit stresses than previously by a more thorough knowledge of the exact conditions of the materials being used. This meeting was a direct result of the AEC's policy to declassify and disseminate technical information as rapidly as possible. The information was released at a meeting sponsored jointly by five scientific groups, the Nuclear Division of the American Society of Chemical Engineers, the American Nuclear Society, the American Society for Testing Materials (ASTM), the Atomic Industrial Forum, and the Society for Nondestructive Testing. The 40 technical papers will be published for the sponsoring groups in the Fall of 1957 in book form by the ASTM. Copies may be ordered at $10 each from ASTM, 1916 Race St., Philadelphia 3, Pa.

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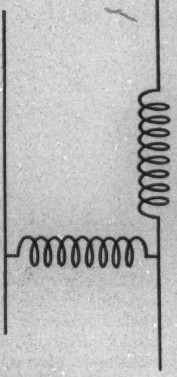

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# INDUSTRIAL NOTES

**Xerography and Oscillography.** A license to manufacture and market xerographic oscillograph machines has been issued to the Industrial Instrumentation Division, Texas Instruments Incorporated, Houston, Tex., under patents and patent rights owned by The Haloid Company, Rochester, N. Y. and Century Electronics and Instruments Inc., Tulsa, Okla. Texas Instruments Industrial Instrumentation Division is engaged in the manufacture and assembly of gravity meters and exploration seismographs for the petroleum industry. The license granted covers use of Haloid's xerographic process in the field of oscillography. Century pioneered the development and use of the process in the field of oscillography and has a number of patent applications in this field which are covered by the license. Oscillography is the trace recording system used in many fields including cardiograph work, seismic exploration, vibration testing, as well as in the recording of stress, strain, heat, and other variables. The instrument utilizes a special paper coated with a photoconductive material especially designed to function in Haloid's xerographic process.

**Company Purchase.** El-Tronics, Inc. announces the purchase of Warren Plastics Corporation and its subsidiary, Cropp Engineering Division, of Warren, Pa. Warren Plastics is a custom molder of plastics, specializing in quantity production of flexiglass polyesters used in electrical components such as a unique home laundry multiple control switch. Other operations include complete production and testing facilities for glass-to-metal seals and multiple headers of both matched and compression types as used in transistors and diodes, also vacuum tube bases for radio and television usage together with the manufacture of appropriate production machinery. The Cropp Engineering Division designs and manufactures rotary plastic molding presses which produce plastic parts of high quality and precision on a mass production scale. Warren Plastics, as well as Cropp Engineering Division, will be a wholly owned subsidiary of El-Tronics, Inc.

**Instrumentation Division.** Monitoring instruments for geophysical equipment, high frequency telemetering systems, and nuclear reactor control and monitoring circuits will be produced by a new division of the Gulton Industries, Inc., Metuchen, N. J. To be known as the Nuclear Instrumentation Division located in Albuquerque, N. M., it will specialize in instrumentation for communications links, instruments, and read-out meters. Ceramic research, performed at the Metuchen facilities, will enable the division to capitalize on findings to achieve miniaturization in nuclear instrumentation. Miniaturization is accomplished because of the high dielectric constant of Glennite ceramics, but more importantly, the use of these ceramics will permit operation at extremely high temperature without suffering damage by heat shock. The Albuquerque plant facilities are being set up to meet Atomic Energy Commission specifications. Production will include ceramic microwave printed circuit components, precision parabolas for solar furnace applications, electronic or manual swept frequency signal generators, supersonic antennas, portable pulsed X-ray units, and neutron sources. Division head will be B. J. Bittner, nationally recognized authority in the fields of telemetry antenna work and nuclear energy.

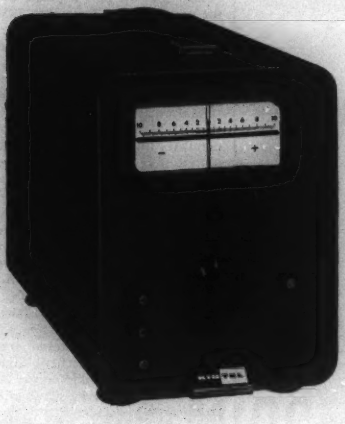
**Division for Test Equipment Sale.** The Jerrold Electronics Corporation, Philadelphia, Pa., manufacturer of electronic equipment for the distribution of television signals over coaxial cable systems, has formed an Instruments and Test Equipment Division. C. C. Cooley will head the new division which will specialize in developing test equipment, designed around new measurement techniques, for industrial and military use.

**General Motors.** Radioactive isotopes are being used at General Motors Technical Center, Philadelphia, Pa., to study certain phases of both production tool and automotive engine wear. A number of special techniques are being developed to handle various wear test problems. Tool wear studies, for instance, are conducted with a large production type lathe. It has been found practical to operate using short half-life, 24-hour tungsten-*187* which is a strong gamma emitter. By using this short half-life material a very high sensitivity and reduction of difficult contamination and disposal problems can be obtained. One microgram of tool material can be easily measured in the chips. This amounts to the material worn off the tool during a single second of operation. In measuring piston ring wear in automotive engines, the company was interested in obtaining the highest possible sensitivity in order to study the details of the wear process as a function of time, instead of obtaining information about the operation of a given lubricant over a period of several hours under constant operating conditions. Higher levels of activity, and more sensitive detection equipment were used to meet these requirements.

**Bendix.** Plans for construction of a new manufacturing, engineering, and research facility have been announced by the Friez Instrument Division of Bendix Aviation Corporation. The new facility will add 66,000 square feet to the present 100,000-square-foot plant in Baltimore, Md. It is being built to meet the increased demand for precision products, including meteorological and aircraft flight instruments, electromechanical missile components, light amplifiers, and closed-circuit television systems, such as the Lumicon (registered trade mark), as well as other complex airborne equipment. The increased

*(Continued on page 28A)*

# NEW
# ELECTRONIC GALVANOMETER



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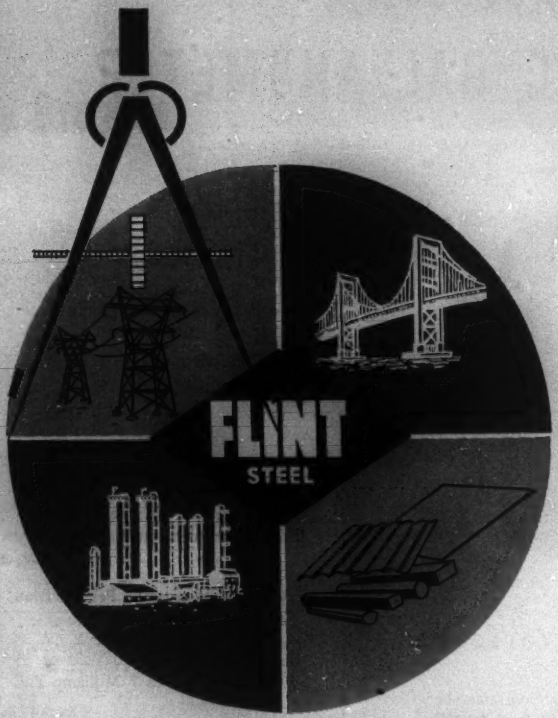


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**TULSA . . . MEMPHIS**

*(Continued from page 18A)*

## Industrial Notes

space, will offer excellent career opportunities for several hundred new employees, including engineers and scientists. Engineering offices, laboratories, and precision instrument assembly and test facilities of the new addition, to be ready for occupancy in December 1957, will be completely air conditioned. The engineering department will occupy the lower level of the two-story addition. The second story of the building will be devoted entirely to manufacturing with certain special areas scientifically designed for the elimination of dust and control of temperature, humidity, and noise level.

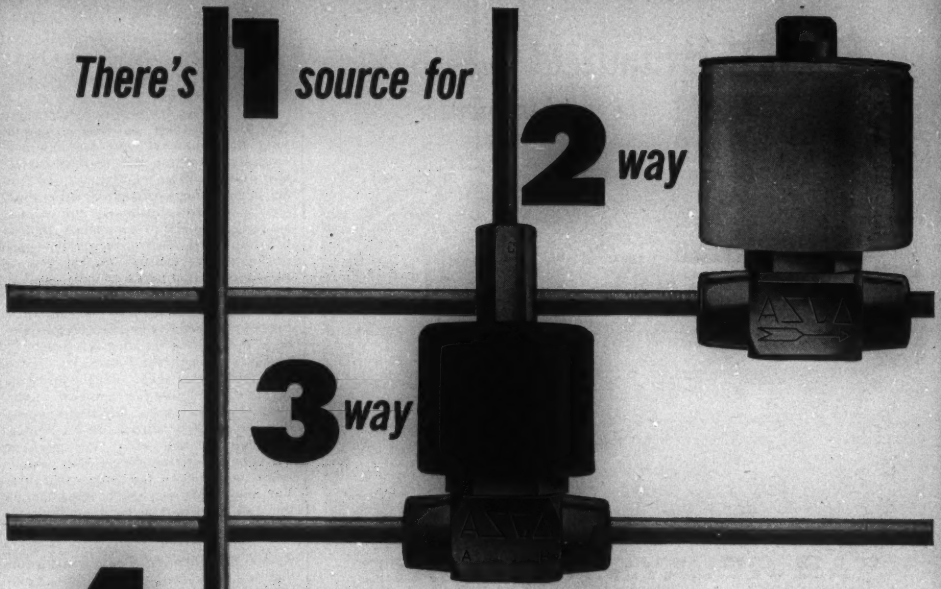
**"Fused-Film" Process.** A method of coating magnet, lead, and hook-up wire with a thin film of insulation that makes possible new strides in the development of smaller and more efficient electrical components in aircraft, electronic, and other applications, has been announced by Adams Consolidated Industries, Inc., 404 5th Ave., New York 18, N. Y. "Fused-Film Wire" is the result of an exclusive new process that converts Teflon (registered trade mark) tape into a thin, concentric filmed insulation 0.002 inch thick. Despite its reduced size, the insulation has dielectric strength and scrape resistance 200% greater than any comparable insulation. Specific uses seen for "Fused-Film Wire" include radar, aircraft accessories, multiconductor cables, small power tools, small motors, refrigerators, and vacuum cleaners. It will be manufactured by Inso Products, Ltd., Union, N. J., the newly formed, wholly owned subsidiary of Adam Consolidated Industries.

**An Outstanding Example.** The Controls Company of America, 2450 North 32nd St., Milwaukee 45, Wis., was recently selected as an outstanding example of a controls company which had shown exceptional growth and an impressive sales picture as well as a company which had produced an interesting and extensive variety of new products, such as the timers, solenoid valves, switches, etc., used in plastic automatic washing machines, and other products. The dramatic story of this company's growth and its aggressive young president who is doing such a capable job of leading the company to a top position in its field was recently told on a documentary television program "This Is the Midwest," in Chicago, Ill.

**"Pure" Inertial Guidance System.** Minneapolis-Honeywell Regulator Company, 2954 Fourth Ave., Minneapolis 8, Minn., has flight tested a new "pure" inertial navigating system for automatic guidance of manned or unmanned aircraft. Several tests have been made from Honeywell's flight operations center at the Minneapolis-St. Paul, Minn. Municipal Airport. The airplane which transported the highly intricate aerial "brain" has ranged over several-hundred mile courses in Minnesota and Wisconsin.

*(Continued on page 30A)*

# There's 1 source for 2 way 3 way or 4 way MIDGET SOLENOID VALVES

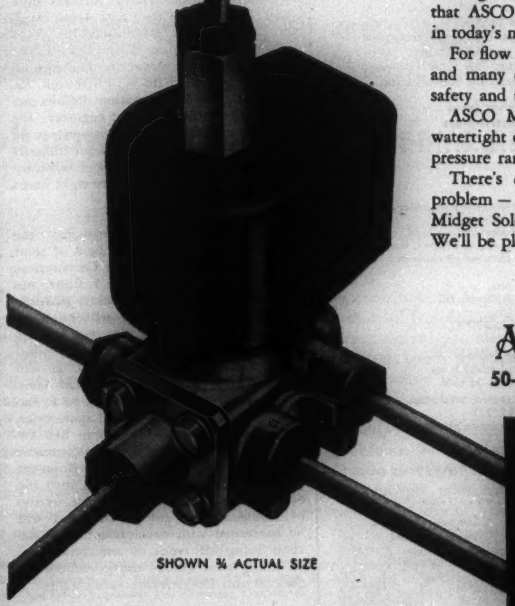


Progressive designers, the men who lead the trend toward miniaturization, depend on ASCO as the one source for a full line of midget solenoid valves. The unexcelled quality and dependability that ASCO pioneered in the solenoid valve field is found, too, in today's midget solenoid valves. Only the size has been reduced.

For flow applications using air, gas, water, light oil, refrigerants and many other liquids, ASCO Midget Valves assure complete safety and truly exceptional performance.

ASCO Midget Solenoid Valves are available with standard, watertight or explosion-proof enclosures. Pipe sizes ⅛" and ¼"; pressure range 0-1000 psi.

There's *one* source that solves virtually any solenoid valve problem — ASCO. Write today for complete data on ASCO Midget Solenoid Valves — or outline any of your requirements. We'll be pleased to assist you.



SHOWN ¾ ACTUAL SIZE

AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES ELECTROMAGNETIC CONTROL

**Automatic Switch Co.**

**50-K Hanover Road, Florham Park, New Jersey**

FRontier 7-4600

ASCO

# Potter & Brumfield *engineering is in this picture*

To automate airframe construction, General Riveters, Inc., designed this giant wing riveter. It clamps the work, drills, feeds and drives the rivets automatically . . . has increased production by as much as 400%, yet requires only a single operator.

## P&B RELAYS AUTOMATE THIS GIANT RIVETER *for New Lockheed Electra Wings...*

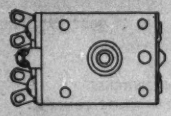
This new automatic riveter will be used to make wings for the new Lockheed Electra, a prop-jet luxury liner, as well as many other modern aircraft. The heart of this riveter is a relay circuit that "takes orders" from a pattern of holes punched in 35 mm film strips.

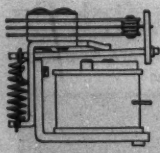
General Riveters, Inc. selected the GA Series P&B relay for the control circuits of this riveter because of its unusual dependability and versatility. In adapting this relay to a specific application, P&B's engineers again demonstrate how 25 years of creative engineering can pay off by providing a standard type or completely new relay to solve your particular problem. Write today for new compact catalog or engineering consultation.

**P&B Standard Relays are available at your local electronic, electrical and refrigeration distributors**

### ENGINEERING DATA GA SERIES RELAY

**Multiple Leaf AC or DC**





**CONTACTS**
**Material:** 3/16" fine silver (other contact materials can be furnished for specific applications)
**Rating:** 5 amp. 115 V. 60c non-inductive load
**Arrangements:** 4 Form C Max., AC, 6 Form C Max., DC
**Breakdown:** 1000 V. RMS between all elements

**COIL**
**Resistance:** 30,000 ohms max.
**Power Req'd:** 6 W. max., 2 W. min. DC at 25° C. ambient
**V range:** DC to 110 V.; AC to 230 V.

**DIMENSIONS, MAX.**
1-23/32" L. x 1-1/16" W. x 1-25/32" H.

**MOUNTING DATA** 4 tapped #6-32 holes, .750" x .875" o.c.; 1 tapped #8-32 core

**ENCLOSURES** Hermetically sealed, octal plug: 2-17/32" x 1-29/32" x 1-25/32"
Multiple solder header and miniature plug-in: 2-15/32" x 1-29/32" x 1-25/32"
Special container required for 6 Form C

**TERMINALS Contacts:** two #16 AWG wires
**Coil:** two #20 AWG wires

## Potter & Brumfield, inc.

*See our catalog in Sweet's Product Design File*

PRINCETON, INDIANA — *Subsidiary of* AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.


*(Continued from page 28A)*

### Industrial Notes

**New General Office Building.** A new 3-story air-conditioned office building now centrally houses the sales and general administrative offices of Reliance Electric and Engineering Company. The building, located at 24701 Euclid Ave. in Euclid, an eastern suburb of Cleveland, Ohio, is the hub of a 69-acre campus-type site serving as headquarters for the rapidly expanding manufacturer of electric motors, motor control, and variable-speed drives and drive systems for industry. Present expansion plans allow for doubling the existing building size at an appropriate time in the future. Because of this, the heating and cooling equipment is located in a tower at a corner of the building so that as the addition is made, the tower will be situated in the center. The entrance and lobby, now offset at the opposite side of the building, would be in the center of the revised structure. The auditorium can also be expanded at the wall to permit access from the new addition.

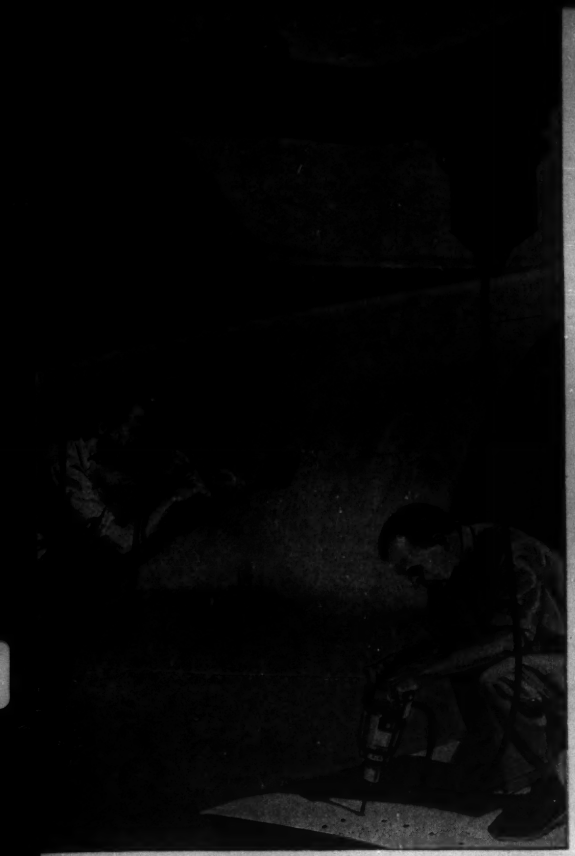
**Rotary Straightener.** A new production line at Columbia Cable & Electric Company, 255 Chestnut St., Brooklyn, N. Y., takes a coil of steel strip and converts it into galvanized electrical metallic tubing completely automatically. The tubing, which meets exacting standards for straightness and roundness, is literally "untouched by human hand" from start to finish. A key installation in the line, which includes an electric-weld tube mill, shear, annealing furnace and quench tank, and a continuous galvanizing line, is a rotary tube straightener built by E. W. Bliss Company's Mackintosh-Hemphill Division, 901 Bingham St., Pittsburgh, Pa. The straightening operation follows annealing. According to plant engineers, the new straightener runs continuously with almost no attention at all. About the only regular manual step is a shot of lubricant to the roll bearings once every eight hours or so.

**Hoffman Electronics.** Recognizing the growing importance of the field of solar energy, Hoffman Electronics Corporation, 3761 S. Hill St., Los Angeles 7, Calif., has established the Hoffman Solar Division. The new division, which will be headquartered in Evanston, Ill., will be concerned with the development and production of solar energy converters. It will operate as a part of the Hoffman Semiconductor Division, also located in Evanston. In addition, Hoffman Laboratories, Inc., wholly owned subsidiary in Los Angeles, Calif., has set up a new department to take over the research and development of semiconductor applications. Called the Semiconductor Equipment Design Section of Hoffman Laboratories, this unit will be concerned with developing new apparatus using all types of semiconductors, including solar energy converters, for industrial and Government applications.

*(Continued on page 36A)*

**Smooth-rolling trolleys tap power** from the duct . . . can be added, removed or relocated in minutes without any downtime or rewiring. Duct is rated at 100 and 225 amps. Special curved sections can be ordered to fit any production line.

**Your BullDog field engineer** will be pleased to give you all the details on Industrial Trol-E-Duct and other BullDog products. Call him. You'll find his know-how very helpful in planning new systems or modernizing existing systems.



# Roll power to the job . . . save production time and dollars!

Can your present electrical system actually contribute to higher production? Here's one that can—BullDog Industrial Trol-E-Duct®! It brings *mobile* power to your assembly lines . . . gives you electrical flexibility that saves time, increases output. Looks to your future, too. When you want to add new production units, just insert a new trolley . . . and forget about rewiring and downtime.

Industrial Trol-E-Duct is but one of many BullDog engineering advances that help solve your power problems. A complete BullDog distribution system, from safety switch to Unit Substation, increases safety and efficiency, saves production time and dollars. Consult your BullDog field engineer now about your electrical system.

© BEPCO

**BullDog Electric Products Company, Detroit 32, Michigan • A Division of I-T-E Circuit Breaker Company • *Export Division:* 13 East 40th St., New York 16, N.Y. *In Canada:* BullDog Electric Products Co. (Canada), Limited, 80 Clayson Rd., Toronto 15, Ontario**

IF IT'S NEW . . . IF IT'S DIFFERENT . . . IF IT'S BETTER . . . IT'S

**BULLDOG**

**ELECTRIC PRODUCTS COMPANY**

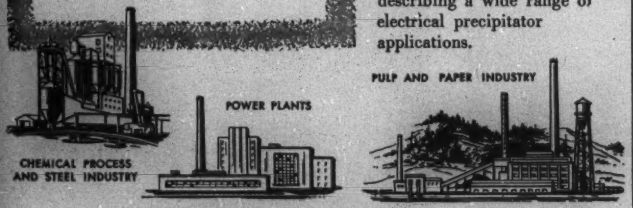
A DIVISION OF I-T-E CIRCUIT BREAKER COMPANY

*Industry looks to*

**RESEARCH -COTTRELL**

*for high dust collection efficiencies*

To maintain visually clean stacks at all times, industry is turning to the long experience of Research-Cottrell in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.




**RESEARCH-COTTRELL, INC.**

A WHOLLY OWNED SUBSIDIARY OF RESEARCH CORPORATION

*Main Office and Plant: Bound Brook, N. J.*

*405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa.*

RC 157 *228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.*



# TELEPHONE AND TELEGRAPH EQUIPMENT

Radio Engineering Products is currently producing a number of types of equipment, electrically and mechanically interchangeable with standard Bell System apparatus.

**CARRIER-TELEPHONE EQUIPMENT**

C5 Carrier-Telephone Terminal (J68756). A kit for adding a fourth toll-grade channel to existing C systems is available. • C1 Carrier-Telephone Repeater (J68757) • 121A C Carrier Line Filter • H Carrier Line Filter (X66217C).

**CARRIER-TELEGRAPH EQUIPMENT**

40C1 Carrier-Telegraph Channel Terminal (J70047C) • 140A1 Carrier Supply (J70036A1, etc.) • 40AC1 Carrier-Telegraph Terminal.

**VOICE-FREQUENCY EQUIPMENT**

V1 Telephone Repeater (J68368F) • Power Supply (J68638A1) • V1 Amplifiers (J68635E2 and J68635A2) • V3 Amplifier (J68649A) • V-F Ringers (J68602, etc.) • Four Wire Terminating Set (J68625G1) • 1C Volume Limiter (J68736C).

**D-C TELEGRAPH EQUIPMENT**

16B1 Telegraph Repeater (J70037B) • 10E1 Telegraph Repeater (J70021A) • 12B82 Teletypewriter Subscriber Set (J70027A).

**TEST EQUIPMENT**

2A Toll Test Unit (X63699A) • 12B, 13A, 30A (J64030A) and 32A (J64032A) Transmission Measuring Sets • 111A2 Relay Test Panel (J66118E) • 118C2 Telegraph Transmission Measuring Set (J70069K) • 163A2 Test Unit (J70045B) • 163C1 Test Unit (J70045D).

**COMPONENTS AND ACCESSORIES**

255A and 209FG Polar Relays • Repeating and Retard Coils, several types • 184, 185, 230A and 230B Jack Mountings.

**RADIO ENGINEERING PRODUCTS**

1080 UNIVERSITY ST., MONTREAL 3, CANADA

TELEPHONE UNiversity 6-6887 CABLES RADENPRO MONTREAL


*(Continued from page 30A)*

## Industrial Notes

**First Atomic-Powered Ship.** The United States Maritime Administration has awarded a contract for design of the first atomic-powered surface ship to George G. Sharp, Inc., 30 Church St., New York, N. Y., marine design firm, and Walter Kidde Nuclear Laboratories, Inc., Stewart Ave., Garden City, N. Y., atomic industrial designers and consultants. Preliminary work will start immediately. Scope of the work includes hull design, nuclear shielding, ventilation, instrumentation, and controls. The vessel's atomic power plant will be a pressurized water reactor similar to the one employed in the *USS Nautilus*, first nuclear-powered undersurface vessel.

**New Westinghouse Plant.** Construction is under way on an ultramodern manufacturing and repair plant for the Westinghouse Electric Corporation, Compton, Calif., near Los Angeles. The concrete and steel building, which will be completed by November 1957, is located on a seven-acre site in the Rancho San Pedro industrial area, 10 miles north of Long Beach, Calif. The building will have 80,000 square feet of plant area and 8,000 square feet of office space, and will provide employment for about 200 people when in full operation.

**Atomic Reactor for Denmark.** The first shipment of an atomic energy reactor from the Port of Los Angeles to Europe has been made, according to Atomics International, a division of North American Aviation, Inc., P.O. Box 309, Canoga Park, Calif., designer and builder of the reactor for the Danish Atomic Energy Commission. The research reactor is a "solution" type, designed to operate at a power level of 5 watts. It will be installed about 20 miles west of Copenhagen. The Danish Atomic Energy Commission will use the reactor for research and training in reactor operation, technology and physics, radio chemistry, and production of radioisotopes.

**Change of Name.** Air Associates, Incorporated, has changed its name to Electronic Communications, Inc. The change has become effective and it is suggested that customers, suppliers, and others use the new name. The name was adopted because of the recent expansion of the firm's activities in the field of electronics. The name Air Associates will still be used for the Division dealing with supplies and accessories for the aircraft industry, heretofore known as the "Aviation Supplies Division." This Division will now be known as the Air Associates Division of Electronic Communications, Inc. The changes outlined do not involve any merger or other change in corporate structure. The same organization will continue business under the new name.

*(Continued on page 55A)*

(Continued from page 36A)

# NEW PRODUCTS

**Accuracy Tester.** The Tempcal (registered trade mark) Tester checks thermal switch and continuous wire systems for accuracy either on the aircraft or "on the bench" in production. It also checks cylinder head thermocouple systems. The Tempcal was developed and is being manufactured by B & H Instrument Co., Inc. The tester performs five basic and vital services: it functionally tests aircraft fire detection and wing anti-ice systems; it tests calibration and accuracy of thermal switches installed on the aircraft; it bench checks calibration and accuracy prior to installation, or in production; it checks cylinder head thermocouples and their circuits (by using a selected part of the Tempcal circuit); and it functionally checks continuous wire systems—the continuous wire, the amplifier, relay and cockpit indicator. Full information about the Tempcal Tester may be obtained by writing B & H Instrument Co., Inc., Fort Worth 7, Tex.

**Cable Puller.** This cable pulling rig for salvaging underground cables has been announced by T. J. Cope, Inc., Third and Walnut Sts., Collegeville, Pa. The heavy-duty puller that can handle 2½- and 3-inch cables applies a strong, positive grip that can readily be released by slackening the winch line. In this fashion, the cable is withdrawn from the conduit. Cope makes a complete line of equipment for installing underground cable. The company also is known for its system of expanded metal trough widely used by utilities and industry as an open type system for supporting and protecting cables.

**Universal Sorting Machine.** Sorting anything from ball bearings to gears and piston pins into as many as 13 categories is now possible on the EAM "Autosorter." The Autosorter is based upon a new no-drift electronic principle of gauging plus a unique and simple mechanical memory system. The same machine can be used for increments anywhere from ten millionths to ten thousandths. Accuracy between classes is guaranteed as low as 0.000002 inch. The speed range averages 10,000 pieces per hour, depending upon the size and type of piece. For changing to different types of work pieces, the top portion containing the mechanical feeding and positioning elements is removed and replaced in from 5 to 10 minutes by means of three cap screws. For visual inspection of balls and rollers, a stroboscopic light in the window indicates out-of-roundness. The equipment is compact, portable, and requires little maintenance. The price is claimed to be considerably lower than the cost of present precision sorting equipment systems. Offered for prompt delivery by EAM Division, Industrial Gauges Corp., West Englewood, N. J.

(Continued on page 56A)

in an instant —THE KILL
Twelve seconds ago, this hostile aircraft came in range of a Navy interceptor. Ten seconds ago, a little black box took control of the Navy craft's weapons system. Four seconds ago it unleashed a salvo of deadly rockets. Two seconds from now the intruder will explode into a ball of fire.
The little black box that takes credit for the kill is an airborne fire control computer designed to make split-second decisions in high-speed aerial warfare. Credit for the black box goes to the Navy, to Lenkurt and other cooperating manufacturers. Developed to meet a specific military need, it is one of the unpublicized but highly important marvels of this electronic age. Everything else about it is classified.
But it can be said that Lenkurt has unique facilities and experience for "black box projects" as well as for commercial and industrial communications systems. You are invited to join the growing list of users — including America's telephone companies, railroads, pipelines, and government agencies — who look to Lenkurt for leadership in telecommunications.
Lenkurt
ELECTRIC
San Carlos, Calif. • Mexico, D.F. • Vancouver, B.C.
Lenkurt Products are distributed to Public Utilities by AUTOMATIC ELECTRIC

# reaching for quality?

BRONCO 66 CERTIFIED CONTROL CABLE

Telsta Corporation reached for quality... insisted on highest quality materials throughout... and chose Bronco 66 Certified Portable Control Cable. The first and only independently powered electric lift, with a single "joy stick" control for the man in the basket, is being manufactured by

**TELSTA CORPORATION**

of Redwood City, California. Communications companies call the Telsta Electric Lift the "first approach to mechanized cable placing." Bronco 66 Certified Portable Control Cable was chosen for the lift because of its outstanding, proven

**weather resistance... dependability... flexibility**

Control and power cables are located within the booms. A take-up reel eliminates the need for slip rings. Cables are exposed constantly to sunlight and ozone. They operate in the presence of oil. They are flexed constantly in operation. Bronco 66 Certified is designed for this kind of gruelling service. Jacket is Certified to contain not less than 67.32% Neoprene for maximum, long-lasting protection. Cables are Synchro-Cured for maximum flex-life.

*Got an "impossible cable application? Bronco 66 Certified is the answer.*

TELSTA Electric LIFT

Manufactured by

**WESTERN INSULATED WIRE CO.**

LOS ANGELES 58, CALIFORNIA


*(Continued from page 55A)*

## New Products

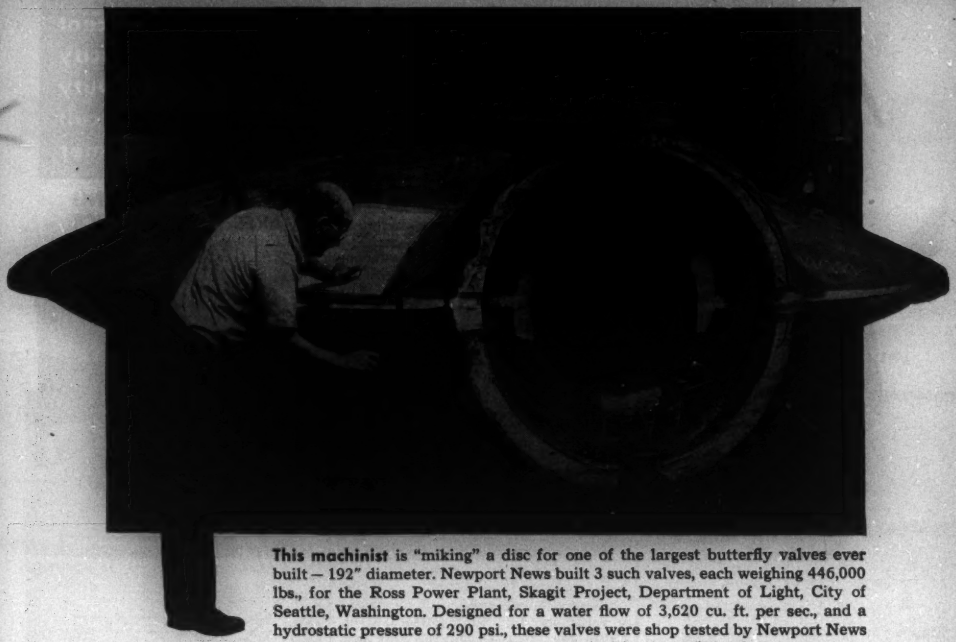
**Carrier-Telephone Terminal.** This terminal provides four toll-grade carrier-derived telephone circuits, one voice-frequency order-wire circuit which may be of toll grade, and frequency space for up to 20 carrier-telegraph circuits, on 4-wire cable, open-wire, or radio circuits, in a transmission band of from 300 to 20,000 cycles. It includes ringing converters, an automatic transmission regulator, and attendant's telephone set. It operates from 115 to 230 volts, 45 to 66 cycles, requiring only 43 watts. Operation over standard loaded spiral-4 field cable is possible at distances up to 40 miles without intermediate repeaters. For further information on the Type *F1450* Carrier-Telephone Terminal contact Radio Engineering Products Limited, 1080 University St., Montreal 3, Que., Canada.

**Installers Truck Body.** Recently perfected by the Utility Body Company, 1530 Wood St., Oakland 7, Calif., is their Series *1-40* installers body for telephone installation and service work. This utilitarian body provides maximum storage space for

necessary parts and materials which are easily accessible. A new feature is the left-hand door, full size to provide for sliding drawers accessible from the driver's side; it has flush, pull-out type door handles with slam-action catches on sides; all locks are master-keyed. The body incorporates all the latest features and fulfills all requirements of the average installer, and can be readily adapted to other urban telephone service problems as well as generalized rural use.

**Protecto-Mask.** The patented protective "hide" that guards polished metals, is now available in five grades, the manufacturer of Protecto-Mask announces. In addition to standard grade Protecto-Mask, long a staple sheathing for aluminum, stainless steel, glass and sheet plastics, now included is Black Weather-Resistant Protecto-Mask, for architectural products; Fabricating Grade, which can be drilled or cut; and Hevi-Duty Grade, which can also be used as sand-blast masking. Descriptive literature on Protecto-Mask is available free from Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39, Ill.

*(Continued on page 58A)*



**This machinist** is "miking" a disc for one of the largest butterfly valves ever built — 192" diameter. Newport News built 3 such valves, each weighing 446,000 lbs., for the Ross Power Plant, Skagit Project, Department of Light, City of Seattle, Washington. Designed for a water flow of 3,620 cu. ft. per sec., and a hydrostatic pressure of 290 psi., these valves were shop tested by Newport News at 450 psi. They are hydraulically operated with oil at 1,500 psi. pressure.

# Birth of a **200-ton** Butterfly

**This disc** for a 16-foot butterfly valve reflects two basic advantages of Newport News fabrication...

First, it exemplifies the *careful attention* Newport News craftsmen give to every detail. And secondly, it attests to the *quality* with which Newport News produces in massive equipment for public utilities and allied industries... due to Newport News' high integration of skill and production facilities.

Additional advantages accrue to customers from extensive work conducted in Newport News' testing laboratories on problems related to water power equipment.

Avail yourself of the engineering talent, along with the specialized production techniques and the skill of Newport News craftsmen operating vast steel fabricating shops, five huge machine shops, drop forging and die facilities along with acres of brass, iron and steel foundries.

Let us bid on equipment for your present or future projects. If you are not familiar with the way Newport News can help you, write for our illustrated booklet entitled "Water Power Equipment" ...it's yours for the asking.

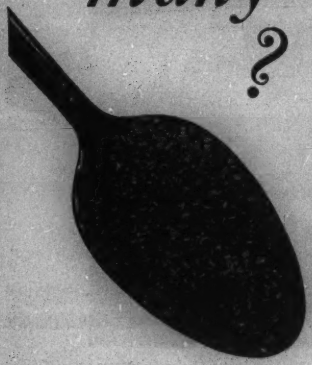
**NEWPORT NEWS**

**Shipbuilding and Dry Dock Company**

***Newport News, Virginia***

(Continued from page 36A)


# how many ?



INSTRUMENT makers are using more and more Johnson pivots. Maybe you're one of them and can tell how many Johnson pivots are held in the teaspoon above.

There's a prize! No world beater, but a handy transistor portable radio to the closest guesser. In case of ties, earliest postmark will qualify.

But you needn't guess when you need precision pivots, accurately machined, scientifically hardened and polished to a metallographic finish. Direct your inquiry to Johnson for satisfaction.

Mail your estimate of the number of pivots in this regular teaspoon now to qualify for the prize. A postcard will do.

**Welton V. Johnson**
Engineering Company, Inc.

*precision miniature parts*

52 SUMMIT AVENUE
SUMMIT 2, NEW JERSEY

LA 1162


## New Products

**Fluorescent Unit.** The development of a shallow all-steel louvered fluorescent unit, which provides an outstandingly modern, trim lighting effect, has been announced by Smithcraft Lighting. Only $3\frac{1}{32}$ inches in depth, the Smithcraft executive, because of its shallowness, is particularly suited for use in low-ceilinged business offices, schools, stores, etc. The Executive's tapered sides are self-illuminated, thus reducing contrast and presenting a soft, pleasing appearance. The egg-crate louvers provide a shielding of 30 degress crosswise and 45 degrees lengthwise. The Executive is available with open top for uplighting or with top reflectors for 100% downlighting. It may be mounted individually or in continuous rows, surface or pendant. The Executive's louver is quickly and easily released by gentle fingertip pressure, and replaced by lifting it back in position. Further information on the new Executive can be obtained by writing Smithcraft Lighting, Chelsea 50, Mass.

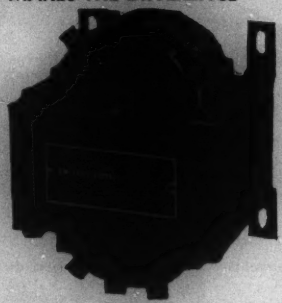
**Whisper Speaker.** A mounted auxiliary speaker designed for automobiles, trucks, taxis, emergency vehicles, boats, and airplanes, has been developed by Carruthers & Fernandez, Inc., Santa Monica, Calif. Called the "Whisper Speaker," the new development is said to combine the clarity and intimacy of headphone reception with the convenience and quality of conventional mounted speakers. When mounted just above ear level, the "Whisper Speaker" provides soft, intimate reception heard only by the person sitting adjacent to the speaker. Although the sound is soft and diffused, it is clearly audible over traffic and wind noises. Multiple installations allow each passenger to enjoy the advantages of the "Whisper Speaker." The unit does not interfere with normal usage of the conventional radio speaker. Universal mounting brackets allow easy installation, even in convertibles and hardtops, without need of panel cutting. The speaker can be removed or repositioned without leaving tell-tale marks or unsightly damage. Special plastic coated wire is easily concealed behind upholstery trim or molding. Sturdily constructed and attractively finished in flock felt, the "Whisper Speaker" is unusually sensitive through the normal tone range. Each speaker provides a panel switch for ON-OFF selection. The unit is complete with hardware and hook-up wire to insure proper installation. All color combinations are available upon request. For additional information, write Frank Fernandez, Carruthers & Fernandez, Inc., 1501 Colorado Ave., Santa Monica, Calif.

**Simplified Cockpit Instrumentation.** A significant development in the field of simplified aircraft cockpit instrumentation has been announced by Autonetics,

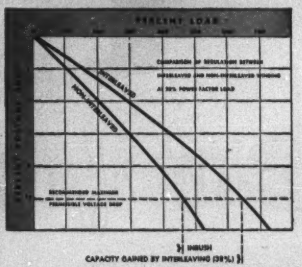
(Continued on page 62A)


**38 percent more capacity with this Hevi Duty control circuit transformer**

**INTERLEAVED WINDING MAKES THE DIFFERENCE**



Type SIO, maximum primary voltage, 600 V




This chart shows that at maximum permissible voltage drop, a Hevi Duty Transformer can handle 38 percent more inrush current than non-interleaved units. This advantage varies from 30 to 80 percent depending on size and design of the transformer.

In addition to superior performance, the higher inrush capacity often enables you to use a smaller size. You then save panel space as well as over-all cost.

Perhaps you can take advantage of the saving that Hevi Duty construction offers. Write for Bulletin T5111 for further data and regulation curves, or send us your requirements.

HEVI DUTY

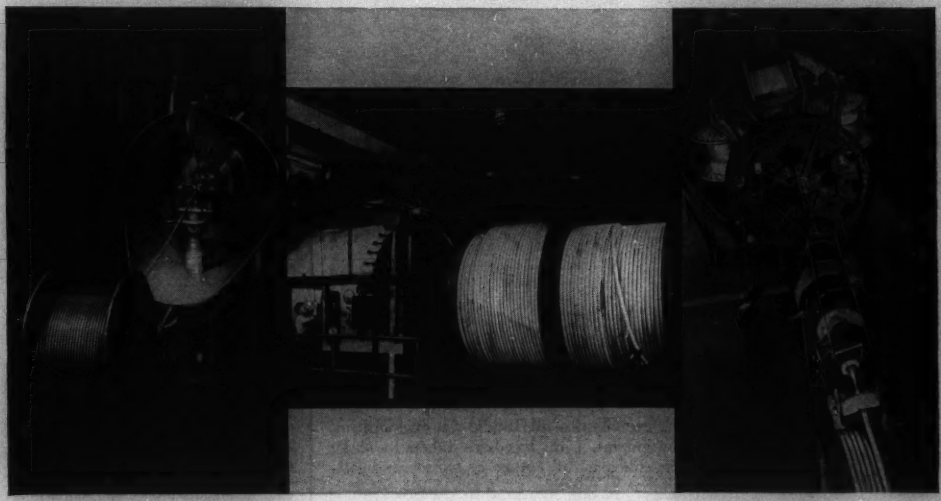
**HEVI DUTY ELECTRIC COMPANY**
MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces . . . electric exclusively
Dry Type Transformers
Constant Current Regulators

## GENERAL CABLE

# PAPER INSULATED
## VERSATILE · RELIABLE
# POWER CABLES

**Manufactured at BAYONNE, N. J. • ST. LOUIS, MO. • EMERYVILLE, CALIF.**



This machine forms steel strip into helical coil ducts or channels for use in gas filled or oil filled cable.

Impregnating Tank utilized in the heat-vacuum drying and oil impregnation steps in the manufacture of Paper Power Cable.

Large Cabling Machine used in cabling individually insulated conductors into multiple conductor assemblies.

- **SOLID TYPE**
- **LOW PRESSURE GAS FILLED**
- **LOW PRESSURE OIL FILLED**
- **PIPE TYPE**
  - **High Pressure Gas Filled**
  - **High Pressure Oil Filled**

The excellent operating record over many years and the superior electrical characteristics of paper insulated cable highly recommends its use for all power applications. Paper Power Cable is a predominant type in preference and use for voltages above 5 KV.

General Cable Corporation is equipped with the finest modern facilities for paper taping and with many years of know-how is in a position to supply a high quality product for all low and high voltage applications.

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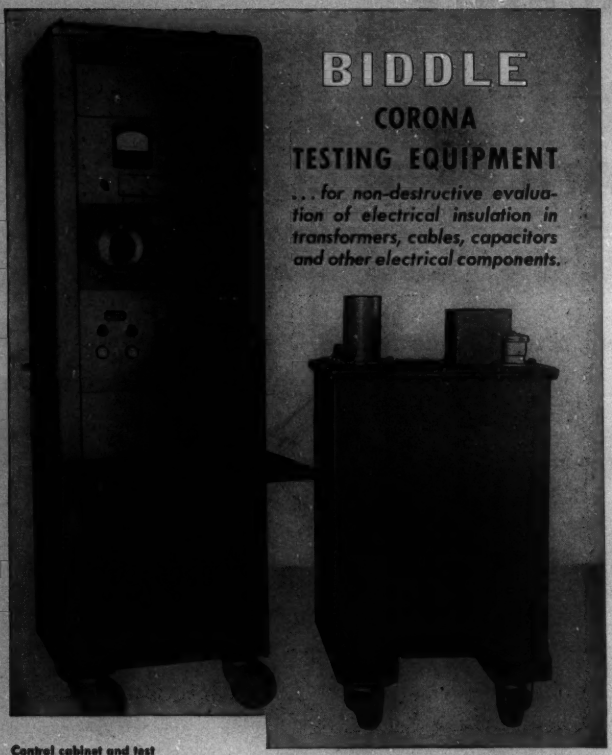
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With the Biddle Corona Test Set non-destructive evaluation of insulation by corona testing is now practical as a production control of quality of insulating structures.

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• SPEED MEASURING INSTRUMENTS
• LABORATORY & SCIENTIFIC EQUIPMENT

1316 ARCH STREET
PHILADELPHIA 7, PA


*(Continued from page 58)*

## New Products

a Division of North American Aviation, Inc., 9150 E. Imperial Highway, Downey, Calif. Called the Instrument Display Projector, the compact device provides at a glance essential information to pilots for completing an instrument landing and, at the same time, allows visual contact outside the airplane. Components are a miniature-type cathode ray tube, a mirror system, collimating optics, or optics that make light rays parallel, and a trichroic combining glass that uses a color contrast principle to enhance definition of the reflected image. With the color separation principle and conventional cathode ray tube, the instrument is capable of obtaining suitable image definition against a bright sky background. In operation, the cathode ray tube's image is reflected by the mirror system to the collimating optics and then to the color-separating combining glass. The combining glass is interposed in the pilot's line of vision immediately in front of the cockpit windshield. Inasmuch as the display is focused to infinity, flight data reproduced on the cathode ray tube appear to the pilot as a bright image suspended in space. As a result, the pilot has no eye accommodation problem, or one that would require him to transfer his visual attention from the tube image to objects outside the airplane.

**Flashers.** A line of patented miniaturized electronic flashers designed to meet the most demanding requirements of vibration, shock, temperature stability, and radio noise suppression, and qualified to all applicable military specifications has been developed by the Electronic Specialty Co. (ES), 5121 San Fernando Rd., Los Angeles 39, Calif. RC oscillator circuits are used and offer significant performance advantages over thermal devices and motor-driven switches. RC oscillators have excellent frequency stability over as much as a 14- to 30-volt range, are easily temperature compensated, and are maintenance free. The output contact arrangement and flasher circuit is readily adapted to any type of warning system. Standard units are available with and without radio noise suppression. Maximum miniaturization is obtained through manufacture by ES of its own relay which has been specifically designed to meet the strenuous requirements of flasher circuits. Flashing rates, output arrangements, and load capacities can be made to meet any requirement.

**Diesel Generator Control Cabinets.** A wide capacity range of voltage output controls for use with stationary and portable diesel generator sets is announced by The Lake Shore Electric Corporation, 205 Willis St., Bedford, Ohio. The controls are provided in three types: top mount, wall mount, and S-type utility models. For further information write to the company.

*(Continued on page 64)*

Giant over-the-horizon antenna designed by Bell Telephone Laboratories for "White Alice," Air Force Alaskan defense communications network.

# *How UHF radio got seven-league boots*

THE huge antenna systems which project ultra-high frequency radio communications beyond the horizon began when a Bell Telephone Laboratories engineer became intrigued with a strange phenomenon. Although these radio waves were supposed to be useful only over line-of-sight distances, the waves displayed a mysterious tendency to take off in a giant stride to antennas beyond the horizon.

This phenomenon had been studied both here and abroad, but no practical use was seen until the engineer became interested and thoroughly sifted the experimental data. He came up with the stimulating conclusion that over-the-horizon transmission is far stronger and much more dependable than was generally supposed. Further he predicted that it could be utilized to supply dependable broadband communications. He and his associates at Bell Laboratories confirmed the prediction experimentally, then drew up requirements for the first over-the-horizon UHF transmission system.

This pioneer work at Bell Telephone Laboratories has greatly increased the usefulness of UHF communications. For example, over-the-horizon transmission now provides critically important communications between remote military outposts in the Arctic and in the far north.

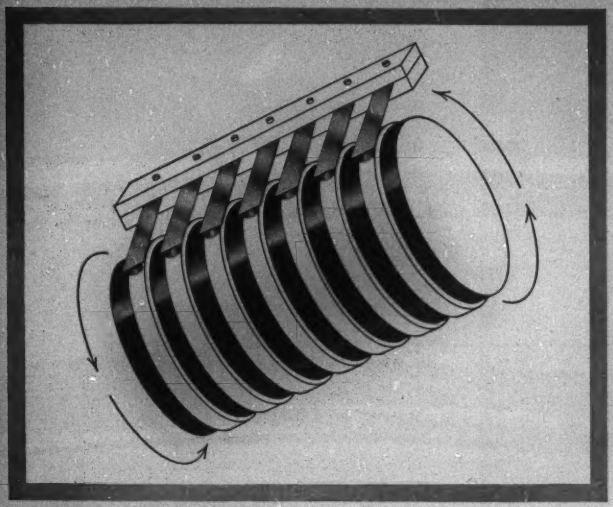
For the Bell System it can provide important new links for telephone conversations and television.

Kenneth Bullington, B.S.E.E., University of New Mexico; M.S., Massachusetts Institute of Technology; recipient of the 1956 Morris Liebmann Memorial Prize and the 1956 Stuart Ballantine Medal for his contributions in the field of over-the-horizon ultra-high frequency radio transmission.

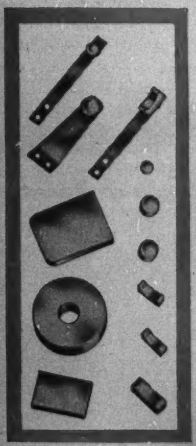
Experimental antenna used in early over-the-horizon UHF radio transmission research. Research extended transmission from 30 miles line-of-sight to 200 miles.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



# Minimizing SLIP-RING CONTACT R-F Noise Levels



Wherever contacts slide or operate against rotating surfaces, there is a good chance that specially developed Stackpole silver-graphite grades will assure good performance with a marked reduction in r-f interference levels.

They have, for instance, been used with outstanding success on applications ranging from radar antenna operating units to calculating machines; from aircraft prop-pitch rotators and de-icers to midget motors; for temperature measurements and on rotating equipment, and in many other uses.

They have assured more stable contact resistance and increased contact life. Equally important, Stackpole's unique high-temperature process for brazing these little contacts to their support arms has greatly simplified assembly operations. Overall costs have been reduced accordingly. Shielding and filters have proved unnecessary in many cases.

The usual method is to operate a silver-graphite contact against a coin-silver slip ring. In some cases, silver-graphite or copper-graphite operating against copper give satisfactory results. It all depends on the application—and that's where Stackpole's years of specialized experience in custom engineering contact material combinations from metal powders pays worth while dividends to contact users.

Details of your slip-ring contact (or brush) application will bring prompt recommendation based on a careful study of the equipment requirements and operating conditions.

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

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*(Continued from page 62A)*

## New Products

**Meter-Guard.** This transparent protective meter cover for Simpson instruments, Models *260, 276, 303,* and *880* is made of super-strong "Involex." This invisible shield slips on over the bakelite meter case to protect against dropped tools and other hazards constantly. Meter-Guard

works while the instrument is in use or in transit, thereby preventing costly and annoying damage to meter glass, case, and movement. Unconditionally guaranteed. $2.50 at parts distributors. Write to Electronic Development Laboratories, 71 Nassau St., New York 38, N. Y.

**Short-Stemmed TV Tubes.** Production of 21-inch 110-degree black-and-white television picture tubes is under way at the Marion, Ind., plant of the Radio Corporation of America (RCA) Electron Tube Division. As a result of extensive development and field tests, RCA becomes the first tube manufacturer to reach full commercial production of 110-degree 21-inch black-and-white picture tubes (*RCA-21CEP4*) incorporating an integral glass-button base, a new electron gun of the "straight" type which functions perfectly without an ion trap, and precision control of the aluminizing process. The RCA Components Division has announced that two companion components have been developed for use with the *21CEP4*. They are a deflecting yoke, which provides a picture area free of geometric distortion, and a horizontal output and high-voltage transformer to provide the required ultor voltage. The components plant at Findlay, Ohio, is in volume production on both items.

**Reflex Transistor.** A new grown-diffused transistor designed for use as both the last I-F and the audio driver stage in a reflex configuration is announced by Texas Instruments Incorporated (TI). Radio manufacturers can now completely eliminate a separate audio driver transistor from their circuits, and build transistorized radios with one less transistor, by utilizing the reflex principle and the new TI grown-diffused *2N310* in 455 kc receivers. Bulletins containing complete design data on the new reflex transistor are available from Semiconductor-Components Division, Texas Instruments Incorporated, Box 7124, Dallas 9, Tex.

*(Continued on page 82A)*

*How to make the most of your engineering career*

ONE OF A SERIES

# *go where engineers don't get lost in the crowd*

One of the many hurdles that can slow down your progress as an engineer is getting lost in the crowd. It can happen in smaller companies as well as in big ones.

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Boeing is one company that takes steps to see that engineers *don't* get lost in the shuffle. Boeing engineers, for instance, work in small integrated teams where initiative and ability get plenty of visibility. Each engineer gets a personal merit review every six months—assuring you a continuing opportunity for individual recognition. In addition, Boeing engineers are eligible for advancement at any time between reviews. There are many other advantages to careers at Boeing—including assignment to exciting missile and jet-age projects, high starting salaries, liberal retirement and company-paid graduate study programs.

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Supervisor of Technical Employment
AC Electronics Div.
General Motors Corp.
FLINT 2, MICHIGAN
MILWAUKEE 2, WISCONSIN

(Continued from page 61A)

## New Products

**Temperature and Ultrasonic Probes.** A series of temperature probes, designed for precise measurements at very low temperatures, is announced by Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. The series is designed to measure temperature changes for such diverse applications as liquid oxygen, guided missiles, and components in electronic circuits. Also put on the market by the company are new ultrasonic probes to provide a simple and reliable method of checking and calibrating ultrasonic equipment. Manufactured by the Vibro-Ceramics Division, the Glennite probes will calibrate ultrasonic medical units, check the operation of industrial ultrasonic equipment, and measure and control ultrasonic intensity levels or beam uniformity. For further information write to L. C. Oakley, Engineering Sales Manager, at the aforementioned address.

**Radio-Geiger Counter.** The atomic age brings forth something new in combination appliances, the Cae Lodestar, which is both radio and geiger counter. This neat portable is designed for carrying in the field. It is housed in a virtually unbreakable case molded of tough Tenite butyrate plastic, and has a strong, resilient shoulder strap made of Tenite polyethylene. The complete unit weighs less than 5 pounds. Simple controls on top of the

case enable the set to be operated as a conventional radio. To operate it as a geiger counter, the ON switch may be turned either to a NEON position so that a light flashes in the presence of radioactive material, or to a CLICKER position so that a clicking noise from the speaker accompanies the flashing light. This affords both a visual and an audible indication of radioactivity. For further information contact Canadian Aviation Electronics Ltd., Ville St. Laurent, Montreal 9, Que., Can.

(Continued on page 84A)

Conference on
MAGNETISM
and
MAGNETIC
MATERIALS
(February 1957)

This 681-page publication covers an extensive compilation of 78 papers in the field of magnetism which were presented at the conference in Boston, Mass., October 16-18, 1956.

The conference was sponsored by the Magnetics Subcommittee of the American Institute of Electrical Engineers Committee on Basic Sciences. Co-operating societies were the American Physical Society, American Institute of Mining, Metallurgical, and Petroleum Engineers, and the Institute of Radio Engineers.

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Living is relaxed and good in the Washington, D. C. area with its mellow climate and spacious suburbs. Our new air-conditioned laboratory is well-instrumented with an eye to future needs and is situated on a wooded 44-acre tract.

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For detailed information on openings, the laboratory, and the industry-free area in which we're located, write:

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*10 miles from Washington, D.C.*

*(Continued from page 82A)*

## New Products

**Differential Transformer Kit.** A laboratory tool, designed for engineers engaged in developing automatic and computing devices, facilitates the conversion of linear displacement to an electric signal. The sensing of position change, both in magnitude as small as 0.0001 inch and in direction, can now be exactly accomplished under experimental conditions. The Atcotran Kit is made up of seven complete differential transformers, having

a linear range from $\pm 0.01$ to $\pm 2.5$ inches, a flexure plate and clamp for positioning coils, and a demodulator which converts a-c output of the differential transformer to d-c voltage. Further information may be obtained from Automatic Temperature Control Co., 5200 Pulaski Ave., Philadelphia 44, Pa.

**Keyboard Control.** A "typewriter" push-button switch for manual keyboard control of electric equipment is being marketed by Micro Switch, Division of Minneapolis-Honeywell Regulator Company, Freeport, Ill. It was developed for rapid-repeat, one-finger operation such as found in the keyboards of electric typewriters, adding machines, and similar equipment. Extremely precise, low-force characteristics give the new switch both snap-action and "tap-action."

**Radiographic Camera.** The newest equipment for low cost radiographic inspection using isotopes is now available from Tracerlab Inc., 1601 Trapelo Rd., Waltham 54, Mass. In addition to the camera itself, Tracerlab offers all the other instruments and services required for the installation and operation of a radiographic inspection facility. For bulletin with complete details, and for further questions, contact the manufacturer.

**Retractable Aircraft Landing Light.** This unit is designed to function efficiently under increased air loads sustained by high-performance aircraft, both military and commercial. Details and specifications will be supplied on request from the manufacturer, Transco Products, Inc., 12210 W. Nebraska Ave., Los Angeles 25, Calif.

*(Continued on page 86A)*

# AIEE STANDARDS

**Standards on electrical machinery and apparatus chiefly devoted to defining terms, conditions, and limits which characterize behavior, with special reference acceptance tests.**

A discount of 50% is allowed to Institute members except as noted. College and bona fide public reference libraries are allowed (except in special cases with † below) a discount of 50% for nonmember prices; dealers and subscription agencies 20%.

| | | |
|---|---|---|
| 1 | General Principles Upon Which Temperature Limits are Based in the Rating of Electric Equipment (June 1957) | $0.80 |
| 1A | General Principles for Rating of Electric Apparatus for Short-Time Intermittent or Varying Duty (Sept. 1941) (A proposed supplement to No. 1—No charge for copies) | — |
| 1B | Guiding Principles for Specification of Service Conditions in Electrical Standards (May 1944) | .40 |
| 1D | Guide for the Preparation of Test Procedures for the Thermal Evaluation of Electrical Insulating Materials (June 1957) | — |
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| 552 | Master Test Code for Electrical Measurements in Power Circuits (Nov. 1955) | 1.20 |
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| | Non-member total | $72.05 |
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* Approved as American Standard.

** A publication approved by the Standards Committee but not as a Standard.

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ON ENGINEERING CAREERS

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Hottest conversation topic in communications circles these days is the all-electronic, transistorized switching system.

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For instance, transistorized switching equipment with no moving parts will increase speeds of data transmission to a degree that seems fantastic in light of present day equipment. Much equipment could be miniaturized to one-fifth its present size. Costs could be reduced right down the line. A host of pleasant innovations in telephone service would become commercially practical.

This important project is challenging the best creative talents of many physicists and electronics engineers at General Telephone Laboratories. A few of the specific projects in work are research in solid state materials, ferrite cores and other types of memory devices, designing circuits and systems, application of digital computer techniques to communications problems.

This, of course, is just one phase of the R&D work at General Telephone Laboratories. But it illustrates the point that the engineer looking for an interesting challenge to mature abilities is likely to find it here.

*Working prototype of electronic switching equipment being checked by a General Tel Labs engineer.*

**Some fast facts about us**

General Telephone Laboratories is the new expanded research and development group of Automatic Electric Company. Our job is the same as it has always been—develop better products and systems in Communications and Controls.

Our parent company, Automatic Electric, is one of the great pioneers in automatic telephony and in the whole field of automation. The dial telephone and long distance dialing are just two of the many "firsts" in their 65-year history.

To the career-minded engineer, General Telephone Laboratories offers a rare combination of advantages... an engineer's company... serving stable but fast-growing industries... interesting and varied work... broad opportunities for personal growth.

Our needs are for engineers in electronics, electrical, electro-mechanical, systems designers, mechanical engineers and physicists.

For specific information about your career opportunities, write direct to Mr. Robert Wopat, president, General Telephone Laboratories, Northlake, Ill.

**GENERAL TELEPHONE LABORATORIES**

INCORPORATED

**NORTHLAKE, ILLINOIS**

*Subsidiary of Automatic Electric Company*


*(Continued from page 84A)*

# TRADE LITERATURE

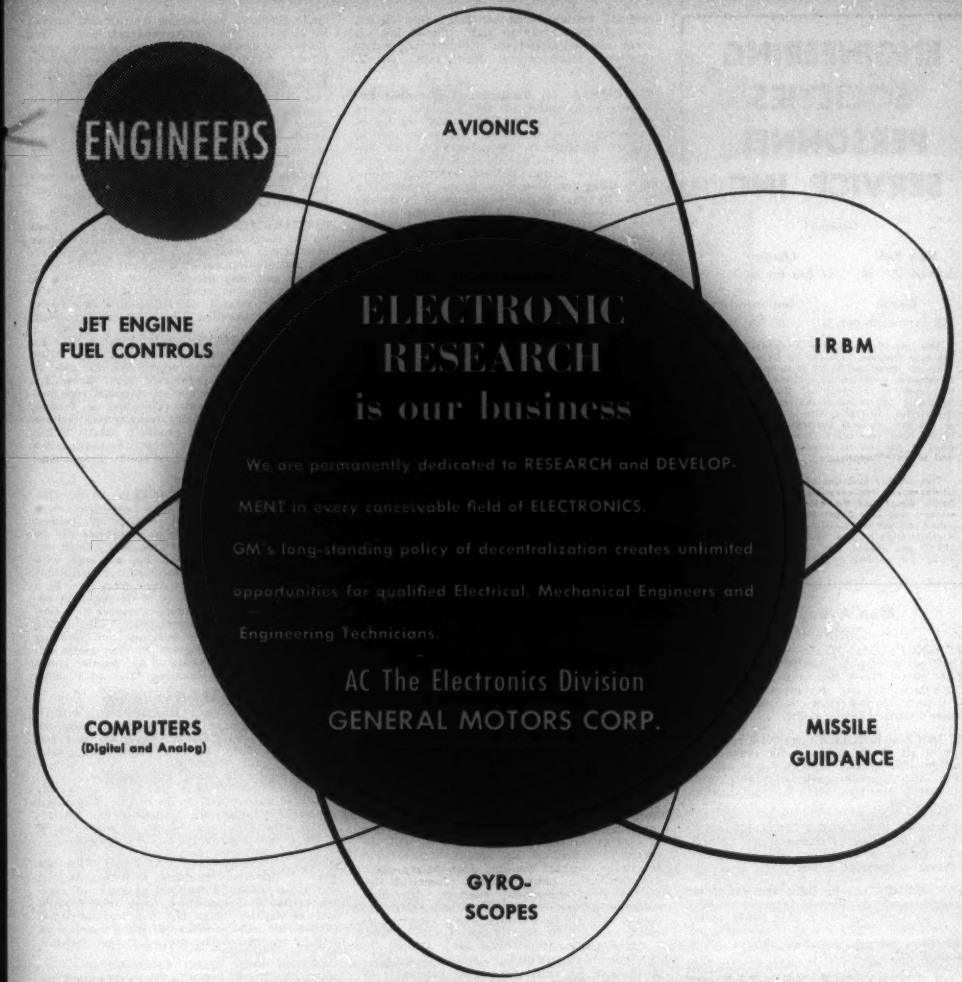
**Weather Brochure.** The role of modern weather sciences in solving industrial problems of production, marketing and distribution, as well as plant location and design, is told in a brochure, "Weather Engineering for Profit," issued by Weather Corporation of America, with offices in St. Louis, Mo. and New York, N. Y. The brochure is documented by actual case histories of weather services to many industries. Of particular interest to the engineering profession is a discussion of how a specialized weather study helped an engineering firm evaluate the merits of a proposed site for a city's additional airport. The brochure discusses, in detail, the growth of industrial weather services and the type of weather engineering studies, interpretative forecasting, and weather modification service provided. Copies of "Weather Engineering for Profit" are available on request to Mr. Hartnett, Weather Corporation of America, 611 Olive St., So. Louis 1, Mo.

**Company Facilities Booklet.** A 12-page brochure describing the facilities of Laboratory for Electronics, Inc., 75 Pitts St., Boston, Mass., has been published. The company is engaged in the manufacture of electronic test equipment component parts for the electronic industries, in the custom manufacture of complex electronic devices, and in electronic research and development. The booklet now available describes and illustrates these facilities.

**Booklet on Floodlighting.** A 16-page illustrated bulletin, "Mercury Vapor Floodlighting," has been published. It contains data on lamp color and operating characteristics and on floodlight beam characteristics, as well as suggestions on how to minimize a stroboscopic effect, and where mercury floodlighting should be used. Descriptions, specifications, dimensions and photometric data on mercury floodlighting equipment, and a table for estimating approximate foot-candles using enclosed aluminum floodlights are also included. Send request for Bulletin *2,696* on your company letterhead to Crouse-Hinds Company, Wolf & Seventh Sts., Syracuse, N. Y.

**Cable Insulation Booklet.** A 28-page booklet "How To Insulate a Cable" explains the four most-used methods employed by manufacturers for applying insulation to electrical conductors. It describes, in easy-to-read nontechnical language, the advantages and the disadvantages of each. Wire and cable users will find the information in this booklet helpful in choosing the right cable design for their needs. They will also learn how important the insulation is in assuring the reliability of an electric circuit. This booklet, the first to describe and compare these four insulating methods, may be obtained by writing for Bulletin *1,106* to The Okonite Company, Passaic, N. J.

*(Continued on page 92A)*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**For Employment Application—Mr. Cecil E. Sundeen, Supervisor of Technical Employment**

**AC THE ELECTRONICS DIVISION**
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**Two weekly bulletins of engineering positions open, one covering positions on the Pacific Coast and the other covering Midwestern and East Coast positions, are published and each is available to members at a subscription rate of $3.50 per quarter or $12.00 per annum, and to nonmembers at $4.50 per quarter or $14.00 per annum.**

## Men Available

TEST ENGINEER, B.E.E.; age 37½; 7 yrs elec and gas util on elec test work; 4 yrs sr des engr for manufacturer elec instruments on special instrument des and devpmt work, portable and switchboard indicating instruments ac-dc. Location desired: Florida. E-902.

ELEC DES ENGR, B.S.E.E.; age 36; 9 yrs exper. Design of all phases of elec indus construction hi-voltage distr general light and pwr, plating facilities and communication, estimating, servo mech. control. Location, overseas, South America or Spain. E-903.

CHIEF ENGR OR ENGRG MGR, B.S., M.S.; age 42; 15 yrs exper in research, des, devpmt, product engrg on electronic and electromech eqpt. Location optional. E-904.

PLANT ENGR, B.S. in E.E.; age 42; 2 yrs manager research and devpmt in metal working plant; 5 yrs plant engr supervising constr, maint and contractors; extensive work in methods and MTM; safety engrg. Location desired: New England. E-905.

DES OR DEVPMT ENGR, M.E.E., B.E.E.; age 30; des and devpmt of large central station generators. Digital computer techniques were utilized in performance calculations. 2½ yrs. Pub util distr exper including substation design of capacitor banks, 3 yrs. Location desired: New York, N. Y. E-906.

## Positions Available

ELECTRICAL ENGINEER, graduate, 35-45, with at least ten years' experience in electric power generation including installation, cost of repairs, maintenance, damage estimates and specifications. Some traveling. Salary, $8000-$10,000 a year. Location, New York, N. Y. W-4728.

ENGINEERING EDITOR, 30-40, graduate electrical, with some familiarity with mechanical phases of design such as drive elements. Must have had experience in the design and development of electrically operated products or those that are electrical or electronic in character. Job will entail evaluation of manuscripts, editing and major rewriting of contributed articles, and original writing based on field trips. Salary, about $9000 a year to start. Travel involves plant calls and attendance at engineering society meetings. Headquarters, New York, N. Y. W-4737.

ENGINEERS. (a) Transistor Applications Engineers experienced in the practical use of transistors and in the design and testing of equipment using transistors. Should be able to analyze intelligently the advantages and disadvantages of transistors in proposed new applications. Will design and test electronic equipment using transistors, etc. Salary, to $12,000 a year. (b) Sonar Engineer experienced in the design and application of complete Sonar systems including transducers, transmitters, receivers and mounting equipment, for the design of Sonar systems or sub-assemblies, etc. Salary, to $12,000 a year. Location, Ohio. W-4756.

ENGINEERS. (a) Senior Electronic Engineers with general experience in the design and application of electronic circuits for a variety of different uses. Will design, analyze theoretically and test modified or new electronic circuits for oscillators, high and low gain ac or dc amplifiers, Sonar transmitters and receivers, etc. Salary, to $11,000 a year. (b) Sonar Transducer Design Engineer, experienced in the design and testing of transducers for use with Sonar systems on ships, submarines, mines or stationary installations. Must be able to design and test transducers of various sizes, power outputs and frequencies. Salary, to $12,000 a year. (c) Servo-Mechanisms Engineer with experience in the design application, theoretical analysis and testing of servo-mechanisms and servo-system components. Will design, direct the design or consult with other engineers on the design of servo controlled instruments, computers, etc. Salary, to $11,000 a year. Location, Ohio. W-4757.

TEACHING PERSONNEL for Department of Electrical Engineering. (a) Instructor in electrical engineering, B.S. in E.E. Salary, $4000-$4400 for academic year. (b) Assistant Professor or Associate Professor of electrical engineering, M.S. in E.E. Salary, $4800-$6500 for academic year, depending upon qualifications. Location, Midwest. W-4764.

EDITORIAL WRITER, electronics engineer, 25-30, for editorial work on a national publication. Will train applicant in writing. Some travel visiting plants, etc. but not away overnight. Salary, about $7200 a year. Headquarters, New York, N. Y. W-4779.

MOTOR SALES ENGINEER for fractional hp electric motor sales to original product manufacturers; graduate electrical engineer with at least five years' experience in the sales engineering phase of electric motors and the application of motors to the appliance field as O.E.M., preferably fractional hp motors. Travel one-fourth to one-half working time. Salary open; expenses paid; company pays placement fee. Should have substantial contacts with high volume industry in the Texas and Oklahoma area as this will be territory. Prefer applicant to locate in Dallas or Fort Worth, Texas. W-4790.

SENIOR ENGINEERS, electrical, B.S.E.E., 28-40, with six years' experience, preferably in industrial plant power distribution in rolling mills. Should be familiar with application of various types of commercially available electrical equipment to processing machinery, such as rolling mills, industrial furnaces, coil slitting lines, etc. Will design, including necessary calculations, power distribution and control circuits for rolling mill equipment; supervise subordinate design engineers, etc. Salary open. Location, Pacific Northwest. W-4796(a).

SENIOR INSTRUMENTATION ENGINEER for Electrical Systems Section; graduate in electrical, mechanical, chemical engineering or physics, advanced degree preferred; with five years' nuclear power plant instrumentation experience, to design and specify non-nuclear instrument systems to measure temperatures, pressures, flow, level and other parameters in nuclear reactor power plants. Salary open, based on experience and qualifications. Company pays placement fees and relocation expenses. Location, Connecticut. W-4803.

ANALOG COMPUTER PROGRAMMER, bachelor's or advanced degree in some phase of engineering, science or mathematics; must include electrical engineering courses and courses in transients and servomechanisms; one to five years' experience in programming analog computers. Also should have experience in programming a variety of problems in different fields. Electrical system design or system analysis experience desirable. Previous nuclear experience valuable but not required. Will prepare computer program diagrams based on equations describing a given problem or physical system; supervise or run problems on modern computing equipment; write brief reports describing each problem completed, etc. Salary open. Company pays placement fees and relocation expenses. Location, Connecticut. W-4805.

ELECTRICAL ENGINEER, graduate, to head up the electrical test section for a manufacturer of electrical insulation. A knowledge of properties and applications of laminated thermosetting plastics and mica products is desirable. Will be company representative of NEMA and ASTM committees related to field of manufacture. Salary open. Location, New York State. W-4809.

PROJECT ENGINEER, under 33, with B.S.E.E., and a minimum of three years' experience. Must know manufacturing processes and be able to work with plant personnel. Must know applications and limitations of standard type materials and components. Company is leading manufacturer of specialty transformers, voltage regulators and applied products. Salary, $7500-$10,000 a year, depending on qualifications; bonus plan and fringe benefits. Location, Connecticut. W-4859.

CHIEF PRODUCT ENGINEER, 35-40, electrical, mechanical or electro-mechanical engineering degree preferred; courses in business administration, accounting or economics will be helpful. Experience should include product development engineering, both line and staff, with a small or medium size manufacturer, preferably of internal combustion engines or at least in a related industry. Experience as development engineer, assistant development engineer or supervisor of a product development engineering function in a company designing and building internal combustion engines or other small machinery is desirable. Salary in five figures; bonus plan; fringe benefits. Location, Midwest. W-4861.

ELECTRICAL ENGINEER, young, with a minimum of two years' experience in rectifiers, some knowledge of transistors and associated circuitry in connection with voltage and frequency regulators. Salary, $7000-$8000 a year. Location, Ohio. W-4862(b).

DESIGN ENGINEER, electrical, preferably under 40, experienced in the design of electrical systems for industrial, commercial and institutional type buildings. Salary, a minimum of $7200 a year. Location, Louisiana. W-4869.

ELECTRICAL-MECHANICAL ENGINEER, not over 35, preferably graduate, with machine-tool experience. Will be required to work out electrical controls for machine tools; related problems of machine design and some hydraulics and pneumatics will be included. Some board work will be required. Salary open. Location, Newark, N. J. area. W-4882.

ASSISTANT OR ASSOCIATE PROFESSOR for Department of Electrical Engineering; Ph.D. or equivalent is required, to teach undergraduate courses. Salary open. Location, South. W-4926.

ELECTRICAL CONSTRUCTION PERSONNEL for large mining project. Superintendent, foreman, office manager, expediter and warehouse man, experienced on powerhouse switchboard, transmission line and plant electrification. Knowledge of Spanish desirable. Location, Peru. F-4935.

ELECTRICAL ENGINEERS OR COLLEGE TRAINEES, 20-30, graduates, from no years of experience up to two years, with interest in power design, maintenance, technical service or production. Should have good technical knowledge and interest that would assist in development for future promotions. Will be assigned to the college trainee program or as electrical engineers, depending upon experience. Location, West Coast. W-4959.

ELECTRICAL ENGINEER, degree, preferably M.S., with administrative ability and knowledge

*(Continued on page 90A)*

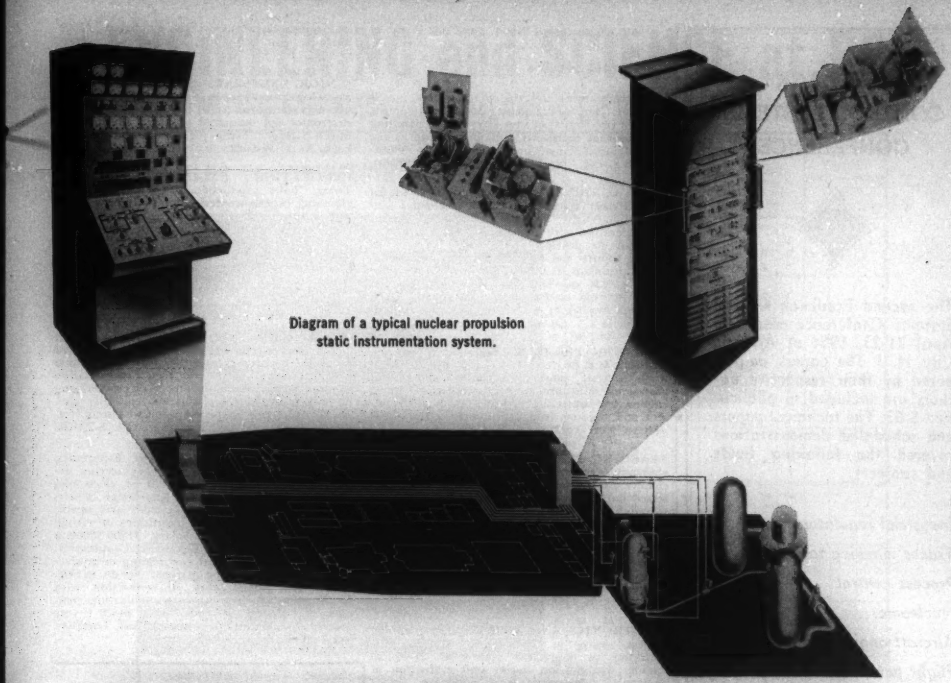

Diagram of a typical nuclear propulsion static instrumentation system.

# DESIGN AND DEVELOPMENT OF STATIC ELECTRICAL INSTRUMENTATION AND CONTROL

At Bettis Atomic Power Division, electrical engineers design electrical instrumentation and control systems and apply improved electrical equipment and techniques to the requirements of nuclear propulsion plants.

Not only must a high degree of reliability be designed into the instrumentation and control systems for a nuclear propulsion plant, but the systems must also employ equipment that is rugged in design, requires a minimum of maintenance, and is built to the exacting requirement of radioactive environments and Navy service.

In connection with development of nuclear propulsion plants for naval vessels, Bettis engineers have developed static electrical instrumentation systems for monitoring power levels, temperatures, pressures, flows and water levels. Conventional instrumentation, which contains moving parts, was particularly sensitive to the shock and vibration conditions encountered under Navy service, and resulted in design compromises and excessive maintenance. The static electrical instrumentation was developed specifically for use in nuclear propulsion plants.

An example is the development of the basic temperature sensing instrument. Instrument response time and performance was improved by redesigning the resistance thermometer for fast response and simplifying circuitry. Magnetic amplifiers were used to amplify the temperature bridge unbalance current to a usable signal level. The amplified signal was used to provide temperature indication at the central station. It was also used in summing, auctioneering, computer, and control circuitry as required to perform the specific functions relating to reactor control.

Magnetic amplifier instrumentation met the requirements for rugged design, minimum moving parts, and a minimum required maintenance.

This is one example of the challenging work conducted at Bettis Atomic Power Division. Engineers interested in electrical control systems, apparatus, nuclear instrumentation and allied circuitry will find excellent professional opportunities available. Address your resume and salary requirements to: Mr. M. J. Downey, Bettis Atomic Power Division, Westinghouse Electric Corporation, Dept. A-178, P. O. Box 1468, Pittsburgh 30, Pennsylvania.

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## FEEDBACK CONTROL SYSTEMS CONFERENCE

The second Feedback Control Systems Conference was held April 21-23, 1954 at Atlantic City, N. J. The papers, as prepared by their respective authors are included in publication S-63. The technical papers and scheduled demonstrations covered the following fields and subjects:

*Industrial regulators*
*Tracer machine tools*
*Process control*
*Nucleonics*
*Aircraft engines*
*Flight path control*
*Fire control*
*Platform stabilization*
*Flight simulators*
*Computers*
*Test equipment*
*Magnetic Amplifiers*
*Potentiometers*
*Gears and dampers*

The preceding list indicates a wide range of applications of feedback control as well as the diversity of components.

This 158-page publication, S-63, is available at the price of $3.50 to members and non-members from the Order Department

**AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS**
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*(Continued from page 88)*

## Personnel Service, Inc.

of carrier current and analog computers, etc. is desirable. To do all phases from development through production of new information handling machine that represents a major advance in the field of business machine systems. Salary, $8000-$12,000 a year. Location, Connecticut. W-4972(a).

ELECTRONICS ENGINEER, M.S. preferred, for wind tunnel research in fluid mechanics and microclimatology. University research projects in cooperation with Federal agency. Program is designed to develop an engineer capable of solving unique and difficult electrical instrumentation problems in fluid mechanics. If applicant holds a B.S. can study for M.S. in E.E., and Ph.D. in fluid mechanics. Can study for Ph.D. in fluid mechanics with M.S. Location, West. W-4980.

TEACHING PERSONNEL, electrical and mechanical, M.S. desired but will consider a B.S., to teach electric power, electronics, mechanical vibrations, fluid mechanics and other mechanical engineering subjects. Salary, $5000 up plus summer and evening teaching if desired. Location, western New York State. W-4982.

TEACHING PERSONNEL, mechanics, applied electricity, general physics. (a) Head of Mechanics Department, Ph.D. in engineering preferred but will consider B.S. or M.S. In addition to mechanics must be able to teach applied electricity (electrical machines and associated circuits). (b) Instructor to teach in the mechanics and physics department, M.S. in mechanical engineering preferred but will consider a B.S. Salary and rank dependent upon qualifications. Salary scale good. Room for advancement. Location, West. W-4988.

ELECTRONICS ENGINEERS, Junior through Project, degree in electrical or electronic engineering, or equivalent experience, 21-40, to conduct qualification testing and evaluation of electronic components and supervise junior engineers and technicians. Analyze test programs and instrumentation, design test methods, evaluate completed data and prepare final reports. Salary, $6000-$8000 a year. Company pays placement fees. Location, New Jersey. W-4994.

ENGINEERS. (a) Leader Industrial Products Sales Group, over 27, electronics degree or equivalent in experience, to manage sales group consisting of 15 salesmen and five engineers. Experience in sales market analysis, research and development. Must have comprehensive knowledge of advertising. Free to travel. Salary, $10,000-$12,000 a year. (b) Government Contracts Administrator, B.S.E.E. or equivalent, to solicit, prepare and administer government R & D type contracts; to serve as administrative assistant to Manager of Engineering Planning Department. Should have contract experience with military agencies; broad contact with technical development work. Salary, $8000-$9000 a year. Location, central New Jersey. W-4995.

ENGINEERS. (a) Head, Government Research and Development, 30-35, M.S.E.E., to direct activities of an R & D group of 10 engineers engaged in advanced technical activities in diverse fields related to data processing. Should have five to ten years' experience in advanced R & D work aimed at government use. Salary, $11,000-$14,000 a year. (b) Head, Product Planning Section, M.S. or equivalent electronics engineer, to evaluate need of technical systems in company's field of interest; propose and specify new products compatible with those systems. Should have experience in system analysis, development work, math., seven to ten years. Knowledge of data handling techniques required. Salary, $10,500-$12,000 a year. (c) Electronic Engineer, Applications and Projects Group, B.S.E.E. degree, with a minimum of three years' practical experience in electronic circuit and equipment design and development including one year in pulse techniques and one year's experience demonstrating ability and capacity to plan, supervise, organize and coordinate technical work. Will work with conversion of telemetry signals from analog to digital form; set up format for digital tape, card punch and paper tape computer, input devices, etc. Salary, $7500-$9000 a year. Location, central New Jersey. W-4996.

JUNIOR ENGINEER, 25-35, preferably graduate electrical, to interview and obtain information for market research, mostly in the fields of electronics and industrial products. Considerable travel. Salary, $7500 a year. Headquarters, New York, N. Y. W-5022.

FABRICATION ENGINEERS, Microwave Tubes. Tube production or development engineering experience desirable. To improve yield and reduce cost of manufacture of traveling wave and klystron tubes. Able to assume type engineering responsibility necessary. Security clearance and citizenship required. Salary, $5796-$10,836 a year, depending upon experience. Location, San Francisco Peninsula. S-2850R.

PROJECT ENGINEER, Controlled Devices, M.S.E.E., major industrial electronics, minor mechanical engineering, with five years' recent industrial electronics preferably in combination with mechanical machinery. To aid in formation of new electro-mechanical section, specializing in industrial electronic and automatically controlled devices. Must be creative and resourceful. Salary open. Location, San Jose, Cal. S-2901R.

ENGINEERS. (a) Project Engineer, Electronics, E.E. or equivalent, to assist in engineering department and shop development of electronics communications equipment. Knowledge of circuits, components and applications and operations and able to supervise technicians in wiring, bench and chassis work. Salary, $7200-$9600 a year. (b) Technicians, Electronic Communications, two years electrical engineering or equivalent, young, "ham type persons," to do wiring, chassis and bench work in connection with development of electronics communication components, units and systems. Salary, $4800 a year and up. Employer pays placement fees. Location, San Francisco, Cal. S-2909.


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| | | | 0-2 | 2-3 | 4-15 | 0-2 | 2-3 | 4-15 | 1-2 | 2-3 | 4-15 | 1-2 | 2-3 | 4-15 |
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| | INERTIAL NAVIGATION | | | W C P | W C P | | W C | W C P | | W C P | W C P | | | |
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(Continued from page 86A)

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## Trade Literature

**Folder on Rotary Switches.** Now available is a 4-page folder on high-speed rotary switches published by Instrument Development Laboratories, Inc., 67 Mechanic St., Attleboro, Mass.

**Polyethylene Booklets.** Two booklets, "Factors Affecting Quality in Polyethylene Extrusion" and "Polyethylene Wire and Cable Insulating and Jacketing Compounds" have been published by the Bakelite Company, a Division of Union Carbide and Carbon Corporation, 260 Madison Ave., New York 16, N. Y.

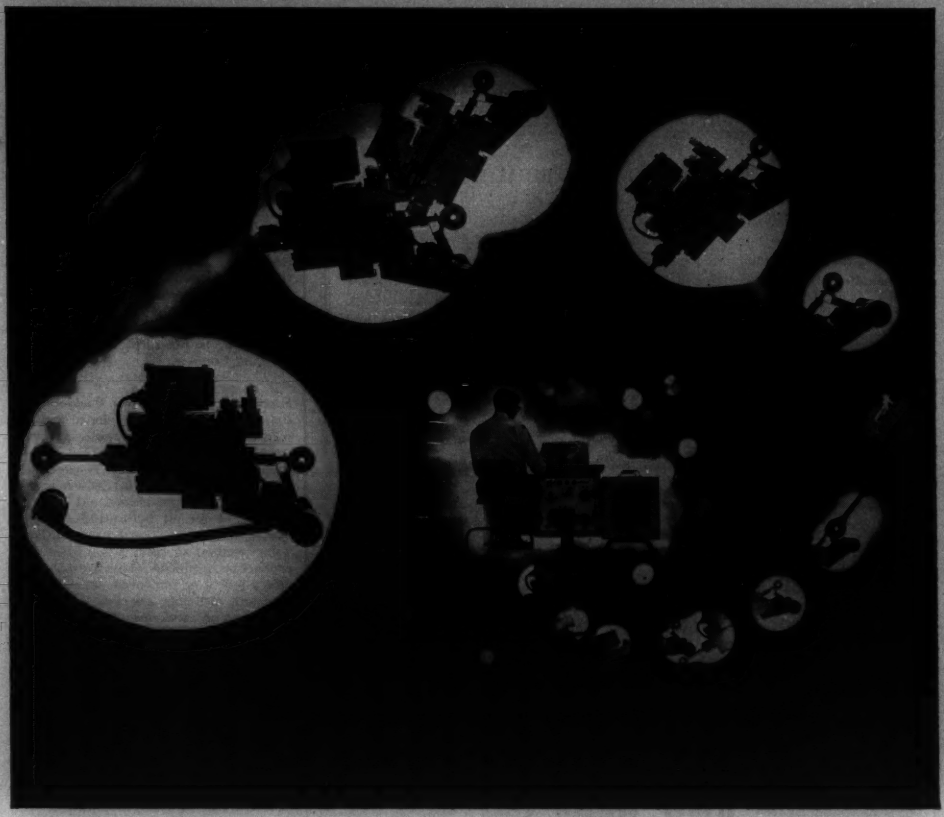
**Precision Instrument Booklets.** Several brochures have been published by Associated Research, Incorporated, 3758 Belmont Ave., Chicago 18, Ill. Particularly, there is Bulletin *10A* which lists the company's line of products. For further information on booklets available write to the company.

**Electromagnetic Control Catalogs.** Seven new catalogs have been issued by the Automatic Switch Company, 50-56 Hanover Rd., Florham Park, N. J. Any of these catalogs are available upon request; letterheads only. They are as follows: *57-S1* automatic transfer switches; *57-S2*, remote control switches; *57-S3*, magnetically held contactors; *57-S4*, relays; *57-S5*, a-c and d-c solenoids; *57-S6*, electric plant controls; and *57-S* containing information from all catalogs, *57-S1* through *57-S6*.

**Magnet Wire Trade Name Directory.** A comprehensive 16-page directory of current magnet wire trade names as used throughout the electrical industry is being offered by the Magnet Wire Division, Essex Wire Corporation, Ft. Wayne 6, Ind. Included are the various trade-name designations as used and submitted by 20 magnet wire manufacturers. In addition to listing the various trade names, the directory gives a brief general description of the physical, chemical, and electrical characteristics and applications common to the ten general classifications of magnet wire. An easy-to-read chart also is included in the back of this book giving a complete resume of trade names by magnet wire types and manufacturer.

**Panelescent Lamp Brochure.** A 4-page brochure, "Sylvania's Panelescent Lamp," has been made available by Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y. Detailed are the construction and characteristics of the new lamp, and pictures of a number of applications of this lamp. Among the applications pictured in the brochure are radio clock faces, radio dials, thermometers, luminous house numbers, illuminated telephone dial, decorative night light, switch plate, selfilluminating sign, and decorative lighting.

(Continued on page 94A)



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*(Continued from page 92A)*

### Trade Literature

**Teflon Handbook.** Release of a 20-page illustrated engineering handbook on Teflon (Du Pont, registered trademark) is announced by TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif. It covers advanced usage in practical applications as a cushioning and insulating material for supporting clamps. This handbook contains all the latest information on Teflon (tetrafluoroethylene) including chemical, thermal, electrical, and aging properties, as well as modern handling methods. A comprehensive tabulated chart, covering 28 tests of the various physical properties of Teflon, is furnished courtesy of the Du Pont Company.

**Simplified Work Methods Booklet.** Work simplification methods developed and used successfully at Minneapolis-Honeywell Regulator Co.'s Aeronautical Division are explained in a step-by-step 20-page booklet issued by the company, which is illustrated with sample charts and flow diagrams and several before-and-after tests photographs. The booklet establishes a 5-step method to solve administrative or production problems. The five steps are: pick a job to be improved, break it down in detail, challenge the job, develop the improvement, and install the improvement. Write to: Minneapolis-Honeywell Regulator Co., Aeronautical Division, 2600 Ridgway Rd., Minneapolis 13, Minn.

**Underwater Detector Booklet.** A new underwater metal detector that can be operated from a boat has been put on the market by Gardiner Electronic Company, 2545 E. Indian School Rd., Phoenix, Ariz. It will locate sunken ships, outboard motors, treasures, items of historical value in salt or fresh water, 300 feet deep. It will penetrate 7 feet through sand, silt, mud, rock, muck, and any type of nonmetalbie medium. It is operated on self-contained heavy-duty batteries. This device is simple to operate and has been repeatedly proved in actual practice.

**Transformer Maintenance Booklet.** A 50-page booklet entitled "Timely Tips on Transformer Maintenance" is available which discusses transformers and their maintenance and includes such subjects as general inspection procedures, classification of transformers, methods of drying out, and transformer connections. It is written for maintenance people in electric utilities, industrial plants, and commercial buildings. For a copy of booklet *B-4716-B*, write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

**Handling Machines Catalog.** An illustrated, 24-page, 2-color catalog describes the latest developments and provides factual information of manually propelled, battery operated, hydraulic lift trucks manufactured by the Big Joe Manufacturing Company, 58 Oak St., Wisconsin Dells 1, Wis. Write for a copy to the manufacturer.